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Cover Photograph: Alabama Phlox (*Phlox pulchra*). The photo was taken in Bibb County. This rare phlox is an Alabama endemic plant that has only been recorded in only nine counties.

Photo is courtesy of: Bill Garland, Biologist.

Editorial Comment:
On behalf of the Alabama Academy of Science, I would like to express my gratitude and appreciation to the reviewers for their valuable contributions in reviewing the manuscripts of this issue:
Safaa Al-Hamdani
Editor: Alabama Academy of Science Journal

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WOODY SPECIES COMPOSITION FOLLOWING A WILDFIRE IN THE DUGGER MOUNTAIN WILDERNESS, TALLADEGA NATIONAL FOREST, AL.

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ABSTRACT

A point-centered quarter survey was conducted within the Dugger Mountain Wilderness in the Talladega National Forest eighteen months after a March 2007 wildfire to determine tree and sapling species composition. In the tree stratum, dominant species were *Quercus prinus*, *Pinus echinata*, *Pinus virginiana*, *Quercus velutina*, and *Oxydendrum arboreum*. The summed importance value of *Quercus* species in the tree stratum was 53.99. Dominant species in the sapling stratum included *Acer rubrum*, *Nyssa sylvatica*, and *Prunus alabamensis*. The importance value of sapling *A. rubrum* (23.62) and *N. sylvatica* (25.73) exceeded that of all oaks combined (16.26). *A. rubrum*, *N. sylvatica*, and *P. alabamensis* were observed to be prolific sprouters following the fire. Unless a pre-Colonial fire regime is restored with the possibility of more intense fires, the high importance value of *A. rubrum* and *N. sylvatica* in the sapling stratum may prevail over *Quercus* species resulting in an overstory dominated by shade-tolerant species with low fire resistance. Due to restrictions on management mandated by the Wilderness Act of 1964, it is not likely that fires of the needed intensity to maintain the current *Quercus* dominated overstory will be possible.

INTRODUCTION

Lightning-caused and Native American set fires historically were a major force in shaping ecosystems of the eastern US (Van Lear and Waldrop 1989, Frost 1998, Abrams 2006). Frequent, low intensity fires created conditions favorable for the establishment and dominance of *Quercus* (Abrams 2000, Van Lear *et al.* 2000) and other fire tolerant species (Wade *et al.* 2000). *Quercus* species have an ecological advantage under a regime of frequent fires due to their thick bark, sprouting ability, and resistance to decay when damaged (Lorimer 1985). In addition, fire reduces soil moisture that would favor mesophytic species, prepares a seedbed by reducing litter thickness, and reduces competition from fire-intolerant species (Barnes and Van Lear 1998, Darley-Hill and Johnson 1981, Van Lear and Watt 1993).

Since the early 1900's, the understory of *Quercus* dominated forests has been invaded by shade-tolerant later successional species, such as *Acer rubrum* (Abrams 2000), that may eventually replace *Quercus* dominance in the overstory (Abrams 2000, Lorimer 1985, McGee 1984, Wade *et al.* 2000). *A. rubrum* and other mesophytic species can become so dense that the

shade reduces *Quercus* seedling and forb abundance. The long-term effect is a reduction in species richness as fire adapted species are replaced by more fire-sensitive species (Nowacki and Abrams 2008). Thus, fire exclusion can be a major disruption in *Quercus* dominated ecosystems (Packard 1993). When fire does return to fire suppressed sites, the mesophytic species are often top-killed but resprout and may dominate the site (Wade *et al.* 2000). Such is the case in Tennessee where repeated low intensity fires reduced *A. rubrum* seedling density, but the surviving *A. rubrum* grew at a faster rate than the *Quercus* seedlings present (Green *et al.* 2010).

The absence of fire in the Dugger Mountain Wilderness could result in unnatural conditions such as the intrusion of mesophytic species into the landscape (Lorimer 1985, McGee 1984, Wade *et al.* 2000), but the use of prescribed fire could result in a less self-willed landscape (Parsons *et al.* 1986) in violation of the Wilderness Act. According to section 2 (a) of the Wilderness Act of 1964, designated Wilderness Areas are to be untrammeled by humans and retain a primeval character that is protected and managed to preserve its natural conditions. The human imprint should be substantially unnoticeable (Hendee *et al.* 1990). The use of prescribed fire in wilderness areas managed by the Forest Service is permitted to reduce fuel loadings but not to restore natural processes (Parsons *et al.* 1986). This study sought to assess the species composition of saplings and trees following a wildfire in the Dugger Mountain Wilderness to determine post-fire regeneration and the potential future overstory.

MATERIALS AND METHODS

The study area was within the Dugger Mountain Wilderness located on the Shoal Creek Ranger District of the Talladega National Forest, Calhoun County, Alabama. This area is in the Southern Ridge and Valley Section and is characterized by low mountains with steep slopes and shallow excessively drained soils. The elevation ranges from 244 to 640 meters above sea level (Soil Conservation Service 1958). A low intensity human caused wildfire burned 267 hectares in the northern end of the wilderness area from February 27-March 4 2007. The surface fire with 0.5 to 1.8m flame lengths consumed primarily hardwood leaf litter and downed hardwood and pine trees.

In September of 2008, 18 months following the fire, a point-center quarter survey (Cottam and Curtis 1956) of trees and saplings was conducted on a 200 X 200 meter grid throughout the burned area. At each point, four quarters were established (northeast, southeast, northwest, southwest). Within each quarter, the diameter at breast height (dbh) and distance to the center of each sapling and tree closest to the center point were measured. Saplings were defined as manifesting woody stems at least 1.4 m tall but less than 11.4 cm dbh. Woody stems greater than 11.4 cm dbh were considered trees. The tree density, basal area, relative frequency, relative density, relative basal area, importance value, and density were calculated for each species in the tree and sapling strata. A pine plantation established before the creation of the wilderness area was excluded from sampling.

Calculations were performed utilizing with the following formulae:
Frequency = number of points containing a species
Relative frequency = frequency/sum of frequencies for all species * 100
Density = number of stems per species
Relative density = density/total number of stems * 100
Basal area = sum of dbh by species/2 * π

Relative basal area = basal area per species/sum of basal area * 100
Importance value = $\frac{\text{Relative frequency + relative density + relative basal area}}{3}$
Area of tree coverage = [(total distance for all species/number of stems)/2]^2 * π
Total stems/ha = 10,000m/area of tree coverage
Stems/ha by species = total stems/ha * relative density

RESULTS

In the tree stratum, dominant species based on importance values were *Quercus prinus*, *Pinus echinata*, *P. virginiana*, and *Oxydendrum arboreum* (Table 1). *Q. prinus* dominated in terms of importance value and density (Table 1). The importance value of *Quercus* species summed to 53.99, while the importance value sum for *Pinus* species was only 22.30, half that of

Table 1. Relative frequency, relative density, relative abundance, importance value, basal area, and density of trees following a wildfire in the Dugger Mountain Wilderness, Talladega National Forest, Alabama.

Tree Species	Relative Frequency	Relative Density	Relative Abundance	Importance Value	Density (stems/ha)	Basal Area (m^2/ha)
Acer rubrum	5.44	4.56	1.42	3.81	21.12	0.08403
Carya alba	0.68	0.42	0.09	0.40	1.92	0.00664
Carya glabra	4.76	5.39	3.79	4.65	24.96	0.14977
Carya pallida	2.04	2.49	1.81	2.11	11.52	0.07088
Cornus florida	1.36	0.83	0.20	0.80	3.84	0.01403
Liriodendron tulipifera	0.68	0.42	0.25	0.45	1.92	0.02113
Nyssa sylvatica	4.08	2.90	1.97	2.97	13.44	0.07639
Oxydendrum arboreum	9.52	8.30	2.95	6.93	38.40	0.16943
Pinus echinata	10.88	10.37	8.51	9.92	48.00	0.30793
Pinus taeda	4.08	2.90	2.64	3.21	13.44	0.09179
Pinus virginiana	9.52	9.54	8.45	9.17	44.16	0.29504
Prunus alabamensis	2.04	1.24	0.34	1.21	5.76	0.02196
Quercus coccinea	0.68	0.42	0.64	0.58	1.92	0.01802
Quercus marilandica	2.04	1.55	0.42	1.38	7.68	0.02880
Quercus prinus	31.97	41.08	59.62	44.23	190.08	1.56035
Quercus rubra	0.68	0.42	1.55	0.88	1.92	0.02805
Quercus stellata	2.72	1.66	0.74	1.71	7.68	0.03794
Quercus velutina	6.12	4.98	4.53	5.21	23.04	0.16066
Vaccinium arboreum	0.68	0.42	0.08	0.39	1.92	0.00639

Q. prinus (44.23) alone (Table 1). *Acer rubrum* and *Nyssa sylvatica* had importance values of 3.81 and 2.97, respectively.

Dominant species in the sapling stratum included *Acer rubrum*, *Nyssa sylvatica*, and *Prunus alabamensis* (Table 2). *A. rubrum* and *N. sylvatica* both exceeded 20% of relative frequency, density, and abundance. Combined the importance value of *A. rubrum* and *N.*

sylvatica was 49.35 and the density was 53.46%. Even when the importance values of *Quercus* saplings was summed (16.26), it did not exceed that of *Acer rubrum* or *Nyssa sylvatica* (Table 2). When considering just saplings ≤ 2.54 cm in diameter at breast height, *Q. prinus* was the fourth most abundant species following *A. rubrum*, *N. sylvatica*, and *P. alabamensis* (Table 3).

DISCUSSION

The species dominating the sapling stratum, *Acer rubrum*, *Nyssa sylvatica*, and *Prunus alabamensis*, have low fire resistance but are prolific sprouters following fires (Hare 1965, Walters and Yawney 1990, Boyer 1990). *A. rubrum* has some characteristics of early successional species, such as rapid invasion of disturbed sites, and characteristics of late successional species, such as high tolerance of low light conditions in the understory (Abrams 1998). The reduction of fire frequency in the 20th century permitted *A. rubrum* to expand from

Table 2. Relative frequency, relative density, relative abundance, importance value, basal area, and density of saplings following a wildfire in the Dugger Mountain Wilderness, Talladega National Forest, Alabama

Sapling species	Relative	Relative	Relative	Importance	Density	Basal Area
Acer rubrum	23.46	26.44	20.95	23.62	160.18	0.10099
Carya glabra	1.24	0.77	2.21	1.41	4.64	0.00839
Carya pallida	1.85	0.77	1.27	1.30	4.64	0.00501
Cornus florida	5.56	4.21	7.60	5.79	25.54	0.03481
Liquidambar styraciflua	0.62	0.38	0.01	0.34	2.32	0.00038
Liriodendron tulipifera	0.62	0.38	0.08	0.36	2.32	0.00113
Nyssa sylvatica	22.84	27.20	27.14	25.73	164.83	0.13899
Oxydendrum arboreum	5.56	3.84	3.24	4.21	23.22	0.01565
Pinus echinata	1.23	1.15	1.89	1.42	6.97	0.00902
Pinus palustris	0.62	0.38	0.99	0.66	2.32	0.00401
Pinus virginiana	0.62	0.38	0.93	0.64	2.32	0.00388
Prunus alabamensis	14.82	13.80	14.14	14.25	83.57	0.06437
Prunus serotina	1.85	1.50	0.22	1.07	6.96	0.00276
Quercus marilandica	1.23	1.15	0.88	1.09	6.96	0.00576
Quercus prinus	9.88	9.58	10.59	10.01	58.04	0.04746
Quercus stellata	1.85	1.53	3.73	2.37	9.29	0.01440
Quercus velutina	3.09	3.45	1.84	2.79	20.90	0.00889
Rhus copallinum	0.62	0.38	0.01	0.34	2.32	0.00038
Sassafras albidum	0.62	1.15	1.51	1.09	6.97	0.00589
Vaccinium arboreum	1.85	1.92	0.78	1.52	11.61	0.00738

moist areas with low fire frequency to dominate the understory of much of the current *Quercus* forests (Abrams 2006).

Acer rubrum (Scheiner *et al.* 1988, Walters and Yawney 1990, Elliott *et al.* 1999, Green *et al.* 2010) and *Quercus prinus* (Elliott *et al.* 1999) have been shown to increase in abundance following fires due to vigorous sprouting. In the Dugger Mountain Wilderness, *Q. prinus*

saplings (≤2.54 cm dbh) were relatively dense post-fire but were well below the density of *A. rubrum*, *N. sylvatica*, and *P. alabamensis* (Table 3). In Tennessee, Green *et al.* (2010) found that low intensity fires reduced *A. rubrum* seedling survival compared to unburned areas, but the low intensity fires did not provide a successional advantage for *Q. prinus* seedlings. The *Q. prinus* and *A. rubrum* seedling survival levels were nearly equal (Green *et al.* 2010). The single low intensity fire in the Dugger Mountain Wilderness may even cause increased sprouting of non-oak species (Arthur *et al.* 1998).

Although *A. rubrum* and *N. sylvatica* did not dominate the tree stratum (Table 1), their dominance in the sapling stratum indicates that the future forest without significant disturbances such as fire is likely to be dominated by these species (Arthur *et al.* 1998). *A. rubrum* and *N. sylvatica* are prolific sprouters following low intensity fires, and low intensity fires may select for *A. rubrum* (Green *et al.* 2010). If more shade-tolerant species become established, the understory microenvironment becomes cooler and moister (Nowacki and Abrams 2008) making the application of prescribed fires of acceptable intensity to favor *Quercus* species more difficult.

Table 3. Stems/ha for saplings ≤2.54 cm dbh following a wildfire in the Dugger Mountain Wilderness, Talladega National Forest, Alabama

Sapling Species	Density (Stems/ha)
Acer rubrum	106.79
Carya pallida	2.32
Cornus florida	2.32
Liquidambar styraciflua	2.32
Liriodendron tulipifera	2.32
Nyssa sylvatica	78.93
Oxydendrum arboreum	16.25
Pinus echinata	2.32
Prunus alabamensis	55.72
Prunus serotina	18.57
Quercus marilandica	2.32
Quercus prinus	34.82
Quercus stellata	2.32
Quercus velutina	6.96
Rhus copallinum	2.32
Sassafras albidum	4.64
Vaccinium arboreum	6.96

Green *et al.* (2010) and Alexander *et al.* (2008) recommend more intense fires or mechanical canopy removal mixed with low intensity fire to reduce the canopy cover. This will reduce the density of *A. rubrum* and allow *Quercus* species with a mid-shade tolerance to receive the light necessary to compete.

Even if a pre-Colonial fire regime is restored to the Dugger Mountain Wilderness, a decline in *Quercus* species and increases in species with low fire tolerance and high shade tolerance are likely. More intense prescribed fire are not likely in a wilderness area where mechanized equipment is not permitted and mechanical treatment to reduce overstory density

would be a violation of the Wilderness Act (Hendee et al. 1990). Thus, the forest within the wilderness area will likely proceed to a mesophytic species dominated forest.

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INTERVASCULAR PIT MEMBRANES IN ROOTS OF TWO SPECIES OF *OSMANTHUS* (OLEACEAE)

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ABSTRACT

Torus-bearing intervascular pit membranes are part of the bordered pit pairs connecting tracheary elements in roots of *Osmanthus armatus* and *Osmanthus americanus*. The pit membrane allows water to pass from cell to cell but blocks transmission of air embolisms. The torus is centrally located on the circular pit membrane and is of such a diameter as to occlude an adjoining aperture when the membrane is displaced during the introduction of air. The center of the torus thickening is strengthened by addition of lignin. Torus-bearing pit membranes are present in secondary xylem (wood) and largely or completely absent from primary xylem. Some pit membranes containing elongate rather than circular tori are the result of fusion of adjacent pits during ontogeny. Torus-bearing pit membranes represent a xeromorphic adaptation that is advantageous during times of water stress.

INTRODUCTION

Bordered pit pairs connect water-conducting tracheary elements of vascular plants and allow water transport from one element to the next. Each pit pair consists of a permeable pit membrane inserted between two pit borders, each with an aperture (Dute *et al.*, 2001). Water passes from the lumen of one tracheary element through the pit pair into the lumen of the neighboring element. Key to the success of the bordered pit pair is the pit membrane, which must allow passage of water molecules yet impede movement of air embolisms.

One modification of the angiosperm pit membrane is its demarcation into a central impermeable torus surrounded by a screen-like margo (Ohtani and Ishida, 1978). It is thought that introduction of air into the system causes the pit membrane to be displaced or aspirated so that the torus blocks an aperture and impedes movement of air bubbles (embolisms). The torus thickening is thought to strengthen the pit membrane and keep it from rupturing during aspiration (Wheeler, 1983; Dute and Rushing, 1987).

The number of angiosperm species known to possess pit membranes with tori totals over 90 (Dute *et al.*, 2010a, 2010b, 2011). Among those species are 17 of *Osmanthus*, a genus of the Oleaceae (Olive Family) (Dute *et al.*, 2010b). Our laboratory has been especially interested in pit membranes of *Osmanthus* for many years, including their structure (Dute and Rushing, 1987), development (Dute and Rushing, 1988) and chemistry (Coleman *et al.*, 2004). We, along with other laboratories, have investigated the systematic distribution of the torus among genera within the family (Ohtani, 1983; Rabaey *et al.*, 2008; Dute *et al.*, 2008). All studies used stem and branch material. Recently, we began a project to survey other organs of *Osmanthus* for presence of torus-bearing pit membranes. As a first step in the study, we observed tori in tracheary elements of leaf veins in perennial leaves of *O. armatus*. We now report on the presence,

distribution and structure of tori in roots of this same species along with another species, *O. americanus*.

MATERIALS AND METHODS

Five specimens of *Osmanthus armatus* Diels used in a previous study (Dute *et al.*, 2012) provided root samples for the present investigation. Plants were potted in a 7:1 pine bark/sand mixture amended with dolomitic limestone, Micromax and PolyOn (17-5-1) and placed in the Alabama Agricultural Experiment Station Greenhouse on the Auburn University campus. Supplementary material was extracted from a core sample of a large root of *O. americanus* (L.) Benth. & Hook. *ex* Gray growing in the Donald E. Davis Arboretum on campus.

Twenty-eight roots were sampled from individuals of *O. armatus*. The root segments selected varied in diameter and in possession of an epidermis *versus* periderm; thus they varied in age. For light microscopy these segments were placed in 3% glutaraldehyde in 0.05 M potassium phosphate buffer (pH 6.8) under vacuum for 1 h, then kept at 4 C overnight. Next, following a brief buffer wash, specimens were dehydrated in a cold ethanol series culminating in two changes of 95% alcohol. Specimens then were infiltrated overnight with JB-4 resin followed by embedment in the same resin. Transverse, radial longitudinal, and tangential longitudinal sections were cut at 3 μm thickness using a Sorvall MT-2b ultramicrotome. Sections were heat fixed to glass slides, stained with toluidine blue O (TBO, Ruzin, 1999), covered with Permount (Fisher Chemicals, New Jersey), and a coverslip was applied.

Mature root samples of *O. armatus* were macerated according to the procedure of Wheeler (1983) by placing specimens in a 1:1 mixture of glacial acetic acid and hydrogen peroxide for three days at 50 C. Following a water rinse, cells of the macerate were stained with TBO and mounted in a drop of water on a slide.

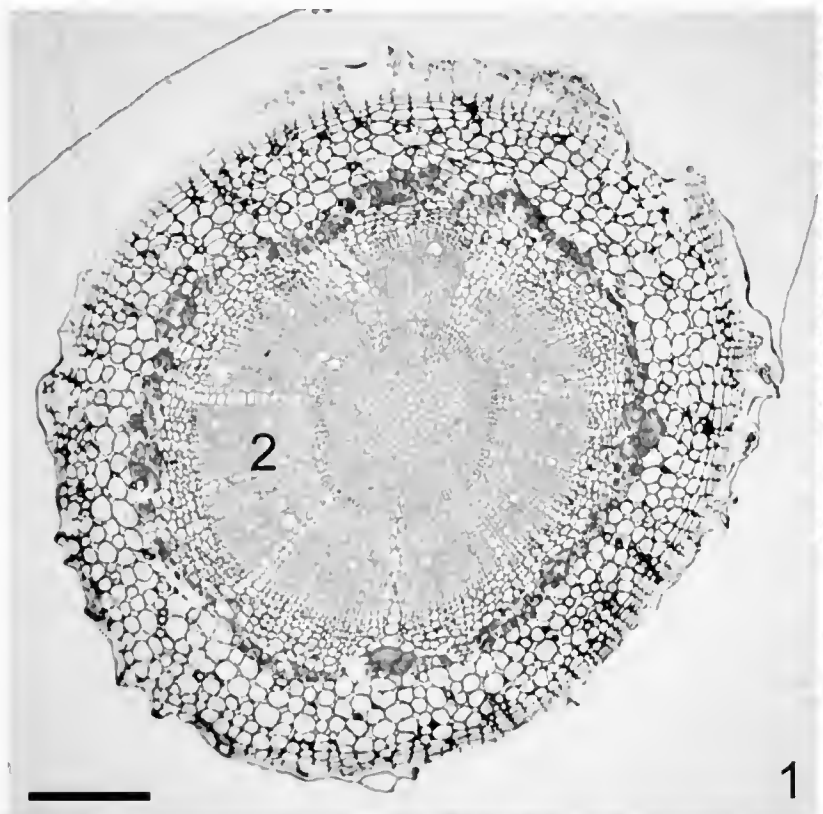
Radial longitudinal root samples for scanning electron microscopy (SEM) from both *O. armatus* and *O. americanus* were air-dried, affixed to aluminum stubs with double-stick carbon tape, sputter-coated with gold palladium and viewed with a Zeiss EVO 50 at 20 kV (Carl Zeiss NTS GmbH, Oberkochen, Germany).

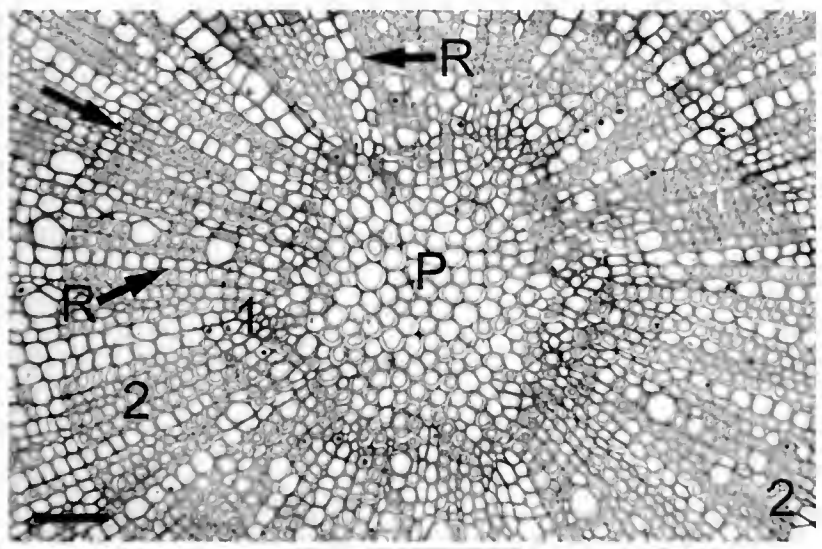
RESULTS

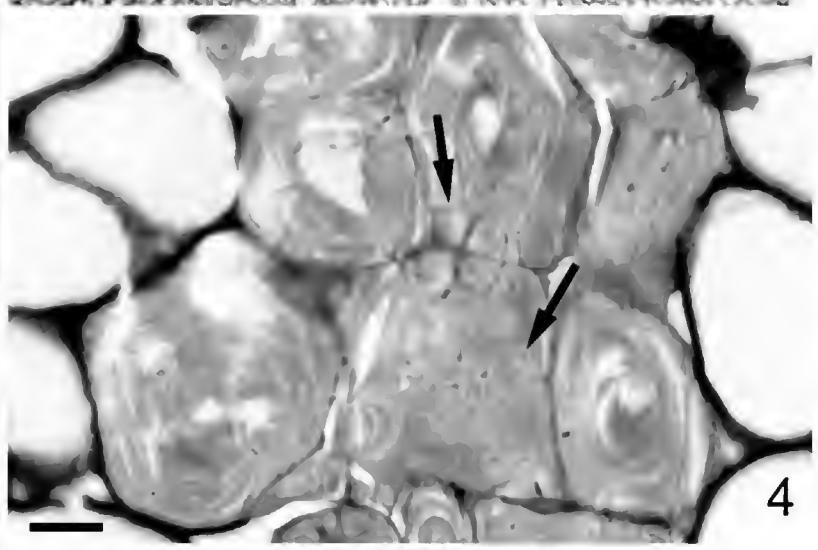
Root Morphology

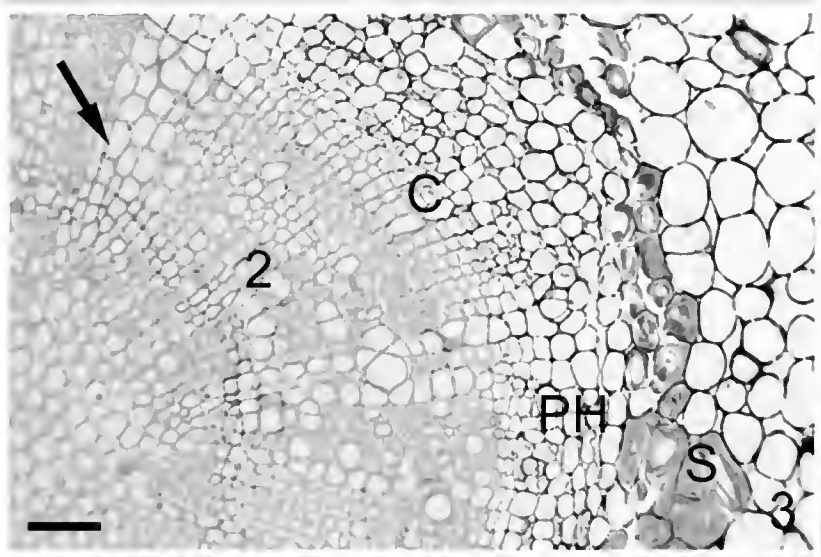
Figure 1 shows a cross section of a root region possessing considerable secondary vascular tissue. Secondary xylem is bounded centripetally by primary xylem and sclerified pith (Figure 2) and centrifugally by vascular cambium and phloem (Figure 3). A ring of sclerenchyma encircles the xylem and phloem (Figures 1 and 3). Detail of the sclerenchyma cells shows them to have pronounced pit canals and multilamellate walls (Figure 4). These cells vary in length but tend to be short and are thus identified as brachysclereids.

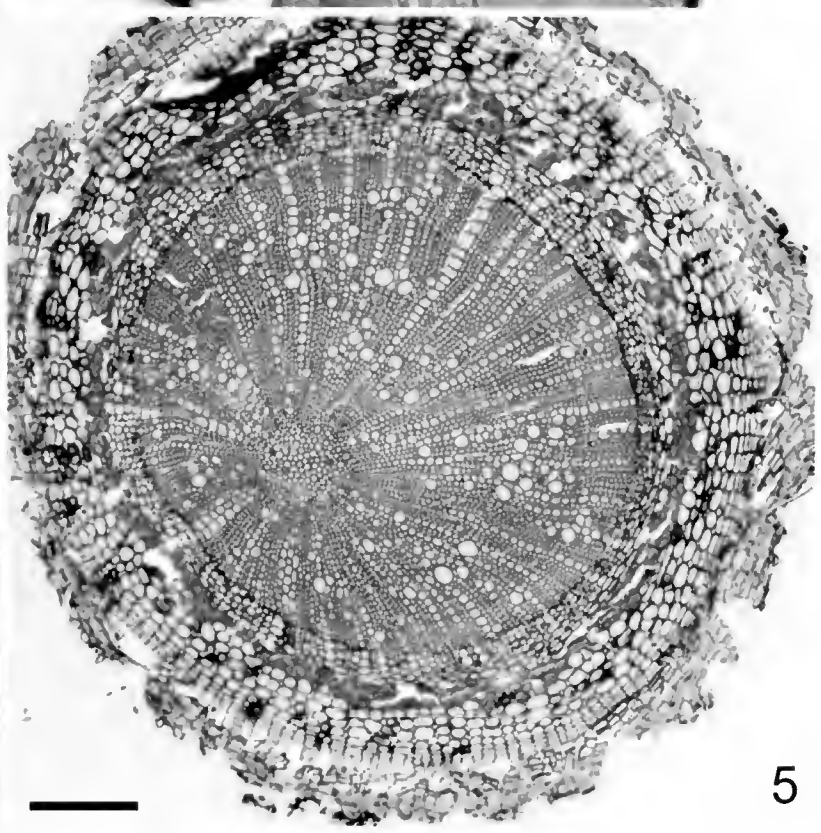
Abbreviations used in the figures in this study: 1 = primary xylem; 2 = secondary xylem (wood); A = aperture of bordered pit; C = vascular cambium; M margo; MX = metaxylem; P = pith; PB = pit border; PH = phloem; PM = bordered pit membrane; PX = protoxylem; R = ray; S = sclereids; T = torus; TR = tracheid; TY = tyloses; V = vessel member. -- Note: Figures 11, 14, 17 and 18 are images of O. americanus; the remaining images are of O. armatus.











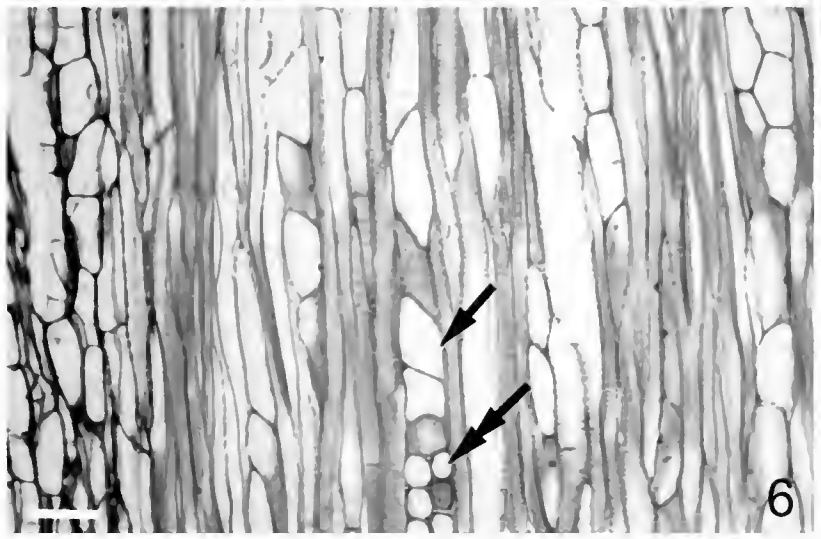


Figure 1. Cross-section of a root with secondary xylem. Scale bar = 250 µm. Figure 2. Center of root showing pith, primary xylem and secondary xylem (wood). The unlabeled arrow indicates the boundary between rings. Scale bar = 50 µm. Figure 3. Secondary xylem is surrounded by vascular cambium, phloem and a ring of (brachy)sclereids. Note the wide ray (arrow) associated with a primary xylem ridge. Scale bar = 50 µm. Figure 4. Detail of sclereids in trans-section. Layers of the secondary wall and pit canals (arrows) are evident. Scale bar = 10 µm. Figure 5. Root cross-section showing eccentric deposition of wood. Scale bar = 250 µm. Figure 6. Tangential longitudinal section of wood. Note how a ray is uniseriate at one level (single arrow) and biseriate at another (double arrow). Scale bar = 50 µm.

Secondary xylem (wood) is either deposited uniformly about the primary xylem and pith or is deposited in an eccentric fashion (compare Figure 1 and Figure 5). Roots are perennial, and in older root segments growth rings are distinct (Figure 2).

Root wood consists of both axial and ray systems. Rays of the ray system generally are narrow, often appearing only one or a few cells in width (Figure 2) in trans-section. Tangential longitudinal sections (TLS) show a more complex situation in that ray width varies along the vertical length of the ray (Figure 6). Rays emanating from the primary xylem ridges become especially wide as diameter of the secondary xylem tissue increases (Figures 3).

Tracheary Elements

Water-conducting cells of the axillary system of the secondary xylem are called tracheary elements and are of two types, tracheids (vascular tracheids) and vessel members (Figure 7). In *O. armatus* both cell types are elongate with helical sculpturing at the lumen surface (Figures 7, 8 and 9). This feature is pronounced in narrower diameter tracheary elements (both tracheids and vessel members). In large diameter vessel members of the spring wood, the sculpturing is faint or absent. Lumen surfaces in *O. americanus* have less pronounced helical sculpturing in the narrow diameter tracheary elements and none in large diameter vessel members. Lateral walls of both cell types in both species possess bordered pits (Figures 8 and 9). Vessel members have simple perforations on their oblique end walls, whereas tracheids are imperforate (Figures 7 and 9). It is the tracheary elements that possess tori in their pit membranes (Fig. 9). At maturity the tracheary elements are dead and devoid of cytoplasm; however, two examples were found of vessel members whose lumens were occluded by tyloses, ingrowths of surrounding parenchyma cells (Figure 10).

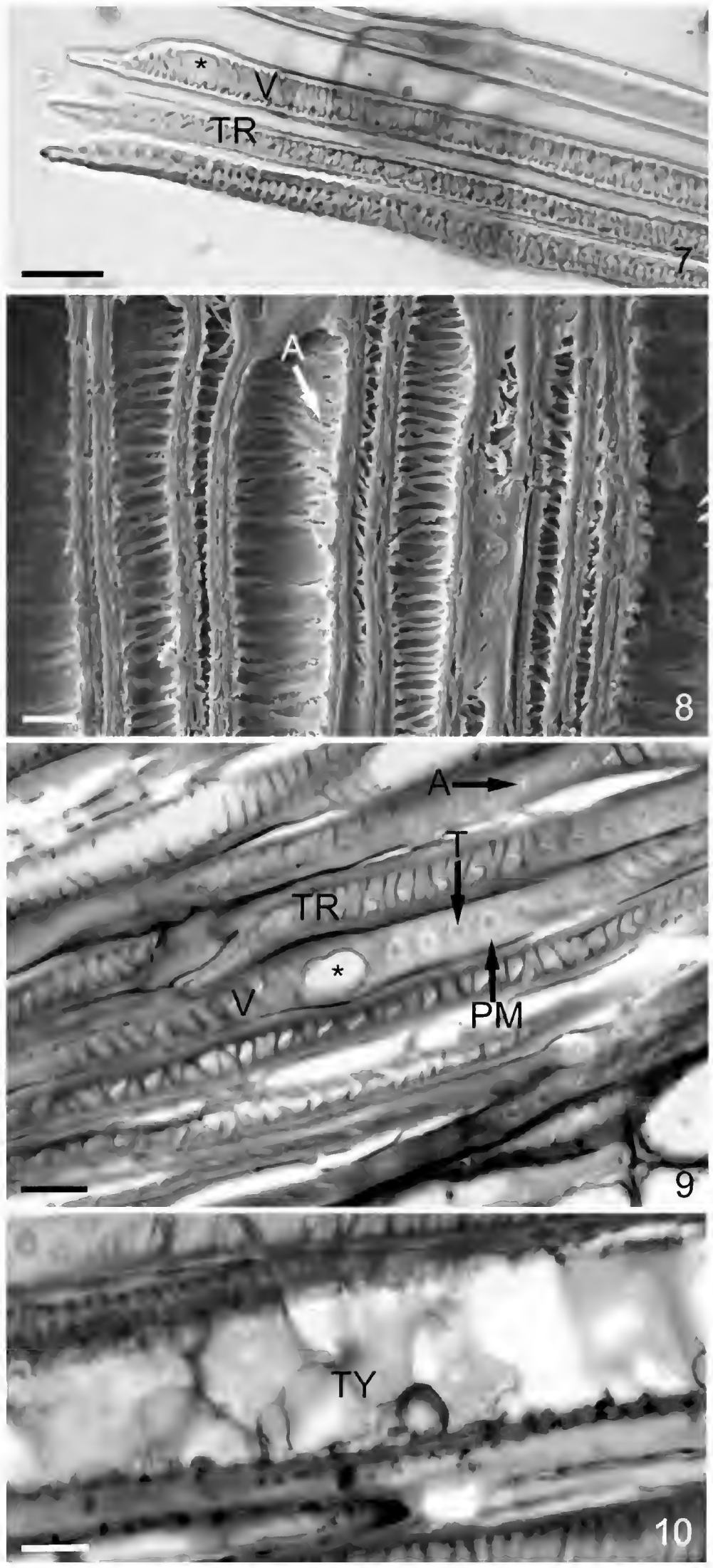
Pit Membranes and Tori

Each pit membrane is sandwiched between two pit borders, each with an aperture providing access to a cell lumen. The apertures are circular in *O. americanus* and elliptical in *O. armatus* (Figures 11 and 12). Resolution provided by the SEM shows that concentric microfibrils compose the pit border (Figure 11). In face view in longitudinal section, the torus is a circular object centrally located on the pit membrane (Figures 9, 13 & 14). The torus stains purple with toluidine blue O, but careful observation shows a blue-green spot in its center (Figure 15). When rotated 90 degrees out of the plane, the pit membrane and its torus are seen in sectional view, and the latter appears lens-shaped (Figure 14). Typically, the diameter of the torus is greater than its associated apertures (Figure 14). For example, as mentioned, pit apertures in torus-bearing pits of *O. armatus* tended to be elliptical. Measurements of SEM material showed the mean of the long axis of the aperture ellipse to be 1.30 μm (N = 25; range 0.77-1.90 μm), whereas the mean torus diameter was 2.21 μm (N = 25; range 1.68-2.20 μm). Mean torus diameter is greater than that of the aperture. Although the ranges of the two sets of measurements overlap, no air-dried pit membranes were observed in which the torus was of smaller diameter than its associated aperture.

The fibrillar nature of the margo, which surrounds the torus, could not be visualized adequately using SEM.

Fused Pits

Perhaps the most interesting aspect of this study is the observation of fused pit outlines in tracheary elements of root wood from both *O. armatus* and *O. americanus*. In some instances it



Figures 7-9. A comparison of tracheary elements using macerated, SEM and sectioned material, respectively. The perforation plates are identified by asterisks. In Figure 8, narrower diameter tracheary elements have more pronounced helical sculpturing. Scale bars = 50 µm for Figure 7; 10 µm for Figures 8 and 9. Figure 10. Vessel member containing tyloses. Scale bar = 10 µm.

appears as if single pits possess borders, tori, and apertures that are distinctly elliptical rather than circular (Figure 16). However, in other cases it is clear that the elongate nature of the pit is the result of fusion of two neighboring pits during ontogeny. Scanning electron microscopy of an example shows the figure eight outline of the pit in more detail as well as the elongate torus (Figure 17). Fused pits have elongate apertures (Figure 18).

Torus Distribution in O. Armatus

Tori are found between small diameter tracheary elements and between small diameter elements and larger diameter spring wood vessel members. Tori are absent between the larger diameter spring wood members.

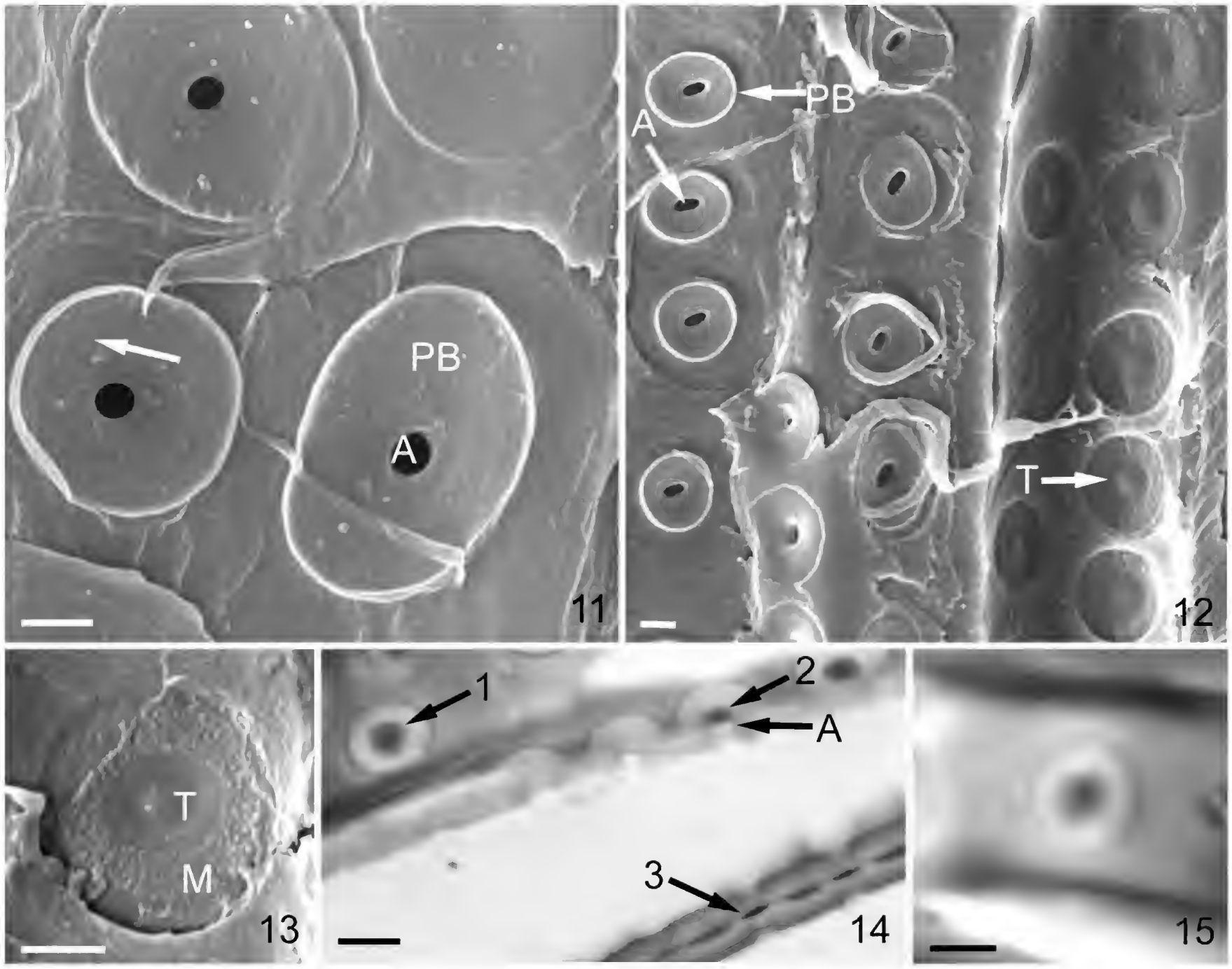


Figure 11. SEM of circular bordered pits with circular pit apertures. Circular microfibrils (arrow) are evident in the pit border. Scale bar = 2 µm. Figure 12. Longitudinal section of tracheary elements seen with SEM showing circular bordered pits. Some pits have their pit membranes exposed. Tori are evident. Other pits have the pit border and elliptical aperture exposed. Scale bar = 2 µm. Figure 13. Detail of a pit membrane showing torus *versus* margo using SEM. Scale bar = 2 µm. Figure 14. Light micrograph showing tori in face view (1), oblique view (2) and sectional view (3). Scale bar = 5 µm. Figure 15. Torus with blue-green spot. Scale bar = 2.5 µm.

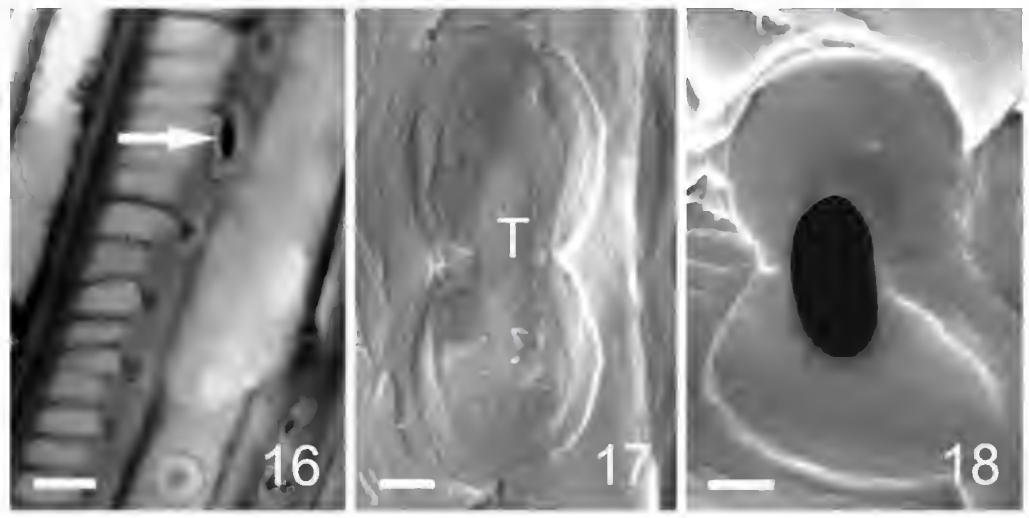


Figure 16. Pit membrane with elongate torus (arrow). Scale bar = 5 µm. Figure 17. Fused pits as seen with SEM. Note the elongate torus. Scale bar = 2 µm. Figure 18. Pit aperture resulting from fused pits. Scale bar = 2 µm.

Primary Xylem

Primary xylem of *O. armatus*, which forms and functions before the secondary xylem, is in the shape of a multipointed star (polyarch stele) surrounding a pith (Figure 19). Figures 20, 21 and 19 show the stele of the root at stages of increasing maturity. In Figure 20, the protoxylem is mature and the center of the stele (the pith) contains a parenchymatous tissue (actually, fiber primordia). Figure 21 shows the stele shortly after the initiation of the vascular cambium. Pith cells have become sclerified. Figure 22 provides a more detailed view of primary xylem ridges and vascular cambium at this time. The latter initiates between the ridges and continues to develop circumferentially until the ridges are ensheathed. Figure 19 shows pith and primary xylem enclosed by wood.

Primary xylem consists of both proto- and metaxylem (Figure 23). The latter matures later and in a position centripetal to (inside of) the former. Figure 24 shows both types of primary xylem in longitudinal view. The later a tracheary element of primary xylem matures, the more extensive is the deposition of secondary wall. Thus the element on the lower right is protoxylem and the pitted element to its upper left, metaxylem. Secondary wall thickenings of the metaxylem can take different arrangements, e.g. Figure 25. In one instance, late metaxylem elements had what might be interpreted as tori. However, this observation needs to be confirmed. Generally, tori are absent from both protoxylem and metaxylem tracheary elements.

DISCUSSION

Microtubules are thought to be responsible for orientation of cellulose microfibrils in walls of plant cells according to the Alignment Hypothesis (Baskin, 2001). Presence of circular microfibrils is observed in both hardwood and softwood pit borders (Harada, 1965a, 1965b; Liese,1965; Schmid, 1965) and is correlated with a ring of cortical microtubules in the adjacent cytoplasm (Chaffey *et al.*, 1997). Thus circular outlines in the pit borders of *Osmanthus* roots as seen with SEM in this study and with atomic force microscopy (AFM) in a previous study of *Osmanthus* stems (Dute and Elder, 2011) should come as no surprise.

In *O. americanus* (and presumably *O. armatus*), construction of the pit border is largely complete by the time that torus thickening material is deposited (Dute and Rushing, 1988). The latter process is itself associated with a plexus of microtubules (Dute and Rushing, 1988). We

hypothesize that the fused pit borders and elongate apertures observed in this study result from a rearrangement of microtubules associated with cellulose microfibril deposition. Subsequently,

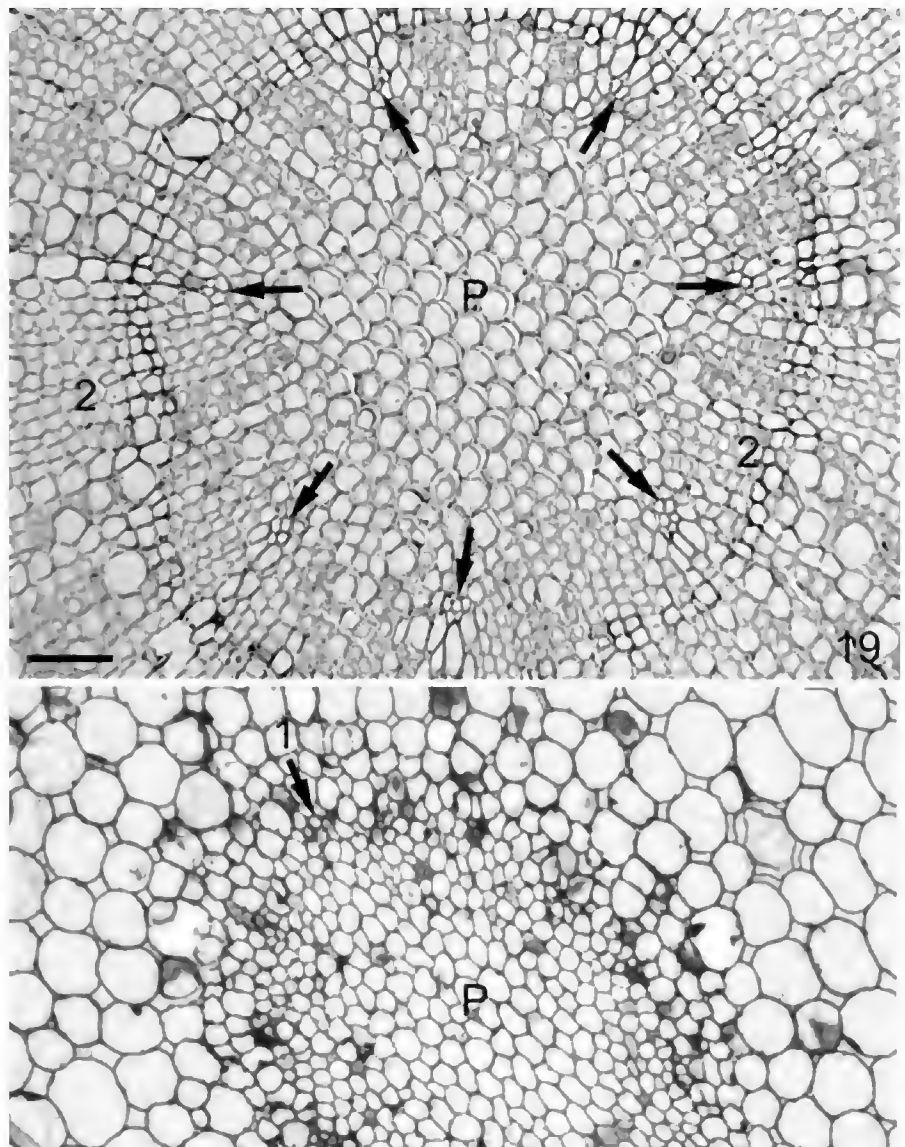


Figure 19. Primary xylem (unlabeled arrows) enclosed by secondary xylem. Scale bar = 50 µm. Figure 20. Section taken near root tip showing only primary xylem. Two primary xylem ridges are indicated. Scale bar = 25 µm. Figure 21. Initiation of the vascular cambium and deposition of the first secondary xylem. Two primary xylem ridges are indicated. Scale bar = 50 µm.

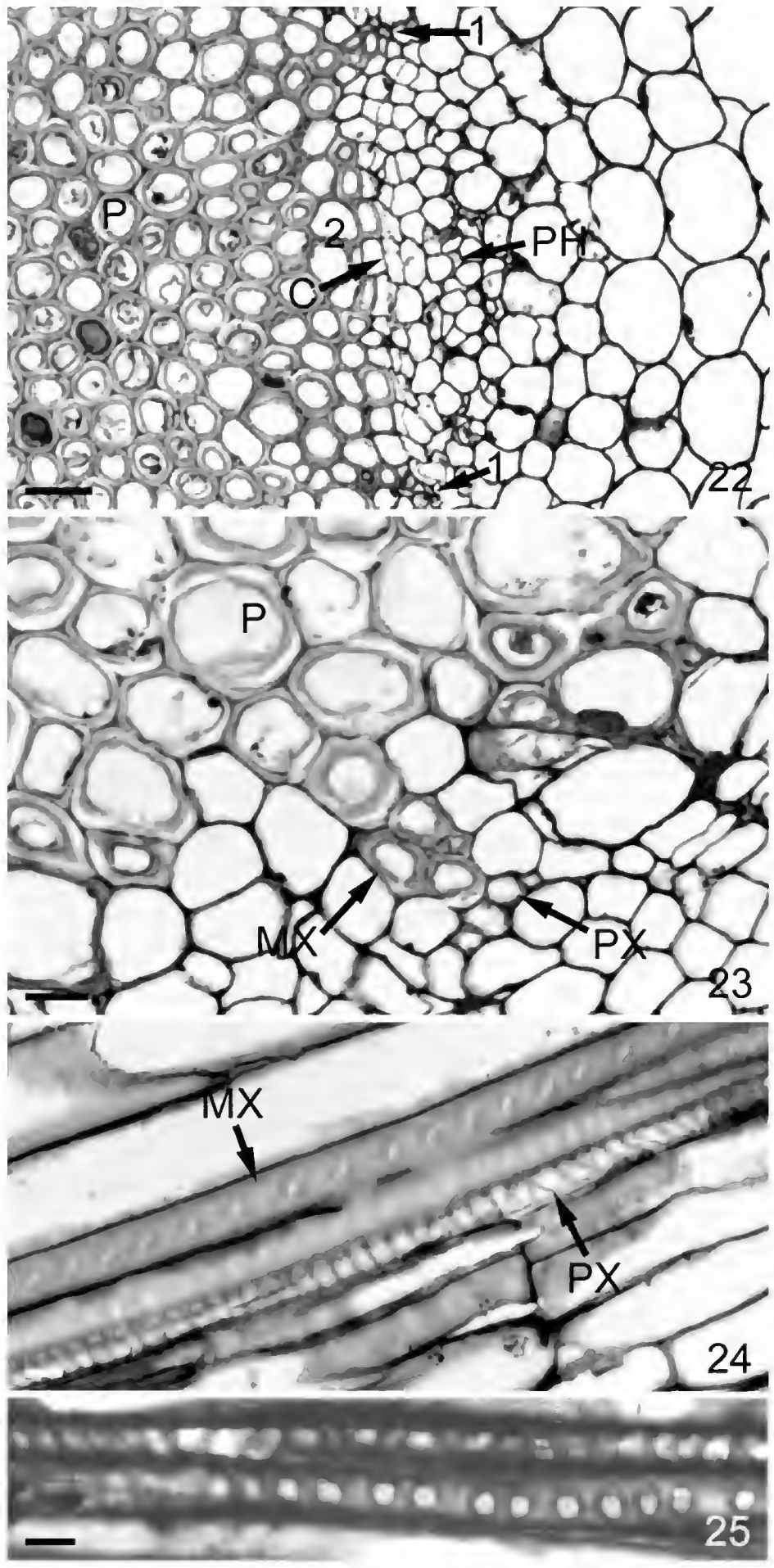


Figure 22. Detail of newly formed vascular cambium. Scale bar = 25 µm. Figure 23. Primary xylem ridge containing both proto- and metaxylem. Scale bar = 10 µm. Figure 24. Protoxylem and metaxylem tracheary elements in longitudinal section. Scale bar = 5 µm. Figure 25. Metaxylem elements with variation in secondary wall thickenings throughout the length of the cells. Scale bar = 5 µm.

shape and dimensions of this elongate aperture affect the nature of the microtubule plexus, leading to formation of an elongate torus. Elongate tori and pit apertures have been observed at the boundary of primary and secondary xylem in petioles of *O. armatus* leaves, but fused pits have not been reported from either branches or leaves of *Osmanthus* (Dute and Rushing, 1987; Dute *et al.*, 2012), although it is expected that they exist.

Transmission electron microscopy (TEM) indicates that the torus of *Osmanthus* consists of a compound middle lamella covered on either side by a torus pad or thickening (Dute & Rushing, 1987). Chemical analysis using acriflavine staining and confocal microscopy shows the torus to contain lignin (Coleman *et al.*, 2004), a wall-strengthening substance (Evert, 2006). TEM of $KMnO_4$-stained material indicates that lignin is localized in the torus pads (Coleman *et al.*, 2004). Detailed views of air-dried pit membranes with AFM show the surface of the torus pad to consist of two parts: 1) a pustular zone surrounded by 2) a peripheral corona of microfibrils (Dute and Elder, 2011). Acidified sodium chlorite removes incrusting material from the pustular surface exposing microfibrils beneath (Ohtani and Ishida, 1978; Dute and Elder, 2011). TBO stains lignin blue-green (O'Brien *et al.*, 1964), and the blue-green spot seen in the center of the torus in the present study corresponds to the pustular zone and to the thickest part of the torus pad where most of the lignin is located. A similar blue-green stained deposit has been discovered in tori of the stem of *O. armatus* (Dute, unpublished results).

Morphology of the typical circular bordered pit and torus-bearing pit membrane of the root of *Osmanthus* is the same as that in the branch and leaf (Dute and Rushing, 1987; Dute and Elder, 2011; Dute *et al.*, 2012). All three organs are perennial and develop considerable amounts of secondary xylem (wood). We are presently investigating flowers of *O. americanus* to see whether xylem of such transient organs possesses bordered pit pairs with tori.

In a recent study we hypothesized that tori in leaves of *O. armatus* represent xeromorphic features which, along with a thick cuticle and sclereids, enable a perennial leaf to survive times of stress (Dute *et al.,* 2012). *Picconia*, a genus closely related to *Osmanthus* (Wallander and Albert, 2000), has pit membranes with tori in its branches (Dute *et al.*, 2008; Rabaey *et al.*, 2008). The two species of *Picconia*, both of which are xerophytic evergreens, grow on the islands of Macaronesia (Caetano Ferreira *et al.,* 2011). One species, at least, (*P. azorica*) "colonizes dry environments and is resistant to sea spray" (Caetano Fereira *et al.*, in press). We would hypothesize that the evergreen leaves of *Picconia* possess tori.

ACKNOWLEDGEMENT

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The Impact of Median Family Income, Shared Religious Affiliation and Region on the Divorce Rate in the United States

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ABSTRACT

Based on a twenty percent sample of U.S. counties (621 counties), this research utilizes a series of multiple regression analyses to examine three issues: A) Does median family income have an inverse association with the rate of currently divorced? B) Does shared religious affiliation have an inverse association with the rate of currently divorced? C) Does region of residence influence the rate of currently divorced? These questions are examined for the years 1990 and 2000, and differences are examined between the time periods. Results show median family income and shared religious affiliation were both inversely associated with current divorce rate; region was selectively important. The influence of median family income, shared religious affiliation, and region was generally weaker in 2000 than in 1990.

INTRODUCTION

Historically, the United States has one of the highest rates of divorce in the industrialized world (Gelles, 1995; United Nations, 2002). The personal, social, and economic consequences of marital disruption on former partners, their children, and American society in general are both pervasive and continuing (Schramm, 2006). Overall, social scientists have made a sustained attempt over the years to more fully understand the factors associated with marital failure and success with the goals of identifying the underlying forces that may lead to marital disruption and finding ways to strengthen marital bonds and relationships. One area of interest germane to this research is to examine if nationally there is a link between divorce rate, socioeconomic standing, shared religious affiliation, and region.

The particular focus of this study is to examine, using county-level data, the ecological impact of selected variables on the divorce rate in the United States. Neither the nature of the data, nor the intent of the research, involves the social impact on the individual. The current research focuses on the extent to which divorce rates are associated with three variables that separately have been shown to be related to divorce rates. Specifically examined is how divorce rates vary with regard to the degree of shared religious affiliation, differences in median family income, and geographic region. The importance of this research lies in the fact that it adds to the known information regarding divorce rates in the United States. It is the first attempt to collectively examine these included variables in their association with divorce rates and to examine such issues over time.

In the last several decades, scores of articles have examined various facets of this issue and related topics (e.g., D'Antonio and Aldous, 1983; Thomas, 1988; Wittberg, 1999) extending from the individual level to large-scale ecological studies. Indeed, important dimensions that may impede marital adjustment and success are the social context within which the institution of marriage unfolds. Economic forces, changing ideas regarding the permanence of marriage, region, "density" of religious bodies within a county, and the decline of community support mechanisms are among the macro-sociological factors that have been found to be associated with a propensity toward divorce (Author Citations; Gruber, 2005; Karney and Bradbury, 2005).

Divorce: The Impact of Income, Religion, and Region

Reviews by White and Rogers (2000), Finnas (2000) and Jalovaara (2001, 2002) have documented the long-standing association between socioeconomic status and divorce, but the relationship is more complex than it initially appears. Socioeconomic measures often operate in combination with such factors as length of marriage and stage of the marriage cycle (Jalovaara, 2002), couple interactions (Gudmunson et al., 2007), wife's income level (Heckert et al. 1998), wife's labor force participation (South, 2001), husband's employment status (White and Rogers, 2000), and monetary assets (Amato & Previti, 2003).

The issue of how religion, socioeconomic status, and divorce are theoretically linked is fundamental to our analysis. It is well established in the literature that socioeconomic status is related to religious affiliation and practice; e.g., conservative Protestants often have little accumulated wealth, while Jewish households tend to accumulate more wealth (Keister, 2003). Likewise, studies indicate a relationship between religious affiliation and divorce; e.g., Baptists have a higher divorce rate (34%) than mainline Protestants (29%), and Catholics and Lutherans have a lower divorce rate, each at 21%, than Mormons with a 24% divorce rate (Robinson, 2006).

Gruber (2005) also describes the connection between religion and socioeconomic status. The "social capital" that is associated with church participation, for example, can provide social contacts that may positively impact economic well-being (such as job mobility), positively influence financial assistance and emotional support during times of need, increase incentives to attend religious schools, and create less stress concerning daily problems. In turn, such influences could increase the likelihood of success in both the employment and marriage arenas. Thus, the social cohesiveness that is generated within the religious setting may influence economic standing and, in turn, other behaviors, including marriage and divorce.

Work by Smith et al. (1998) has pointed out that religious affiliation is less likely to predict socioeconomic status than in the past. Thus, the association between income and religion may be weaker than expected. Further, Smith and Faris (2005) concluded that "socioeconomic inequality in the American religious system has been quite persistent and stable, suggesting that significant mobility within this system in the mid-20th century may be declining, thus producing a more stable system of stratification" (p.95).

Theorists have studied the interrelationship between religious beliefs and other social phenomena since the nineteenth century (Booth et al., 1985; Turner, 1991). Particularly relevant to the current topic is research that reports an inverse association between shared religious affiliation and divorce rates (Mullins et al., 2009). Additionally, Gruber (2005) found that higher "religious density" is associated with increased levels of church attendance, which in turn is associated with higher levels of income, education, and marriage rates, but lower rates of divorce.

Central to the notion of religion as an integrative force are the shared belief systems and values concerning life's ultimate questions that originate from the group experience, as Durkheim indicated (1965, p. 239). A key question for this research focuses on this general issue, utilizing the societal institution of marriage as the focus of examination. Does the extent of shared religious affiliation within a community impact the dynamics of the marital relationship, including propensity toward divorce? If so, then the divorce rate should be lower in communities where there is greater identification with fewer religious organizations and higher where fewer persons identify with the same group.

Questions remain concerning the extent to which religion serves as a socially integrative force in contemporary, post-industrial society (Chaves and Gorski, 2001; D'Antonio and Aldous, 1983; Thomas, 1988). Researchers have taken different perspectives on this issue. One approach suggests a weakened role of religion and religious institutions in the exercise of social control following modernization (D'Antonio, 1983) and increased secularization (Chaves, 1994). Other arguments (Chaves and Gorski, 2001) focus on whether religious vitality is enhanced or undermined by increasing levels of religious pluralism. The general conclusion is that religion continues to be an important integrative and social control mechanism for those who are more heavily engaged in its practice, influencing a variety of behaviors in the process.

Social integration theory (Durkheim, 1966) suggests that divorce in part is influenced by the degree of normative consensus to which couples are exposed and the extent to which social control mechanisms (often intertwined with religious considerations) influence conformity to marital expectations. Following this perspective, higher divorce rates are associated with social settings where there is less agreement on behavioral norms and lower expectations regarding conformity to the marital role. Greater normative agreement and heightened social expectations should produce more marital stability (Durkheim, 1966:208-210).

The influence of religious factors on economic systems has generated interest since the earliest days of sociology, most notably in Weber's (1958) classic examination of the link between Protestantism and capitalism. Numerous studies have since investigated the influence of economic considerations on divorce, with almost all indicating an inverse relationship between marital dissolution and socioeconomic status (see Gelles, 1995:396-398 for a review). A notable exception is Clydesdale (1997), who found that upper income status, especially rising to that level, significantly increased the chances of divorce.

An additional structural factor germane to understanding divorce is geographic region of the country. Explanations for regional differences in divorce rates have focused mainly on varying levels of cultural homogeneity in the United States; i.e., the lower the level of cultural homogeneity, the higher the rate of divorce. Traditionally, a greater degree of cultural homogeneity and normative agreement has existed in the older, eastern parts of the U.S. versus the developing areas of the West (Glenn and Shelton, 1985). Additionally, higher geographic mobility is associated with the western region of the country, apparently contributing to elevated divorce rates in that region. Regional variations in the divorce rate are not explained wholly by differences across regions in religious composition. Despite the relative concentration of Catholics and Jews in the Northeast, for example, the low divorce rate in that region does not reflect the overwhelming dominance of any one denomination whose normative expectations oppose divorce (Glenn and Shelton, 1985).

The essential issues examined in the current research focuses on three questions. First, does greater income, measured by median family income at the county level, have an inverse association with the divorce rate? Second, does greater shared religious affiliation at the county

level have an inverse association with the divorce rate? Third, does the rate of currently divorced vary by region of residence? These questions are examined in three ways: A) as individual zero-order effects, B) as parts of regression effects when additional variables known to be related to divorce are controlled, and C) in a temporal context by performing comparable analyses using data from 1990 and from 2000.

MATERIALS AND METHODS

Sampling Procedures

The analysis is based on data pertaining to 621 U.S. counties. A random sample of 20 percent of the counties from each state was selected. The original universe consisted of the 3,111 counties that existed in the U.S. at the time of the 1990 census. The 2000 data reflect these same 621 counties. Both the 1990 and 2000 data are drawn from the same two sources: the decennial censuses of population and housing for those years (U.S. Bureau of Census, 1992, 1993, 2002) and the Glenmary Research Center (Bradley et al., 1992; Jones et al., 2002).

Although it would have been preferable to use all U.S. counties for this analysis, this was not possible given practical considerations. The shared religious affiliation measure for 1990 (derived from Glenmary Research Center data) was hand calculated due to the lack of a computerized database at that time. While the 2000 Glenmary data were available in electronic format, we chose to retain the same counties in 2000 as in 1990. A complete set of data for all variables was compiled for each county for both time periods.

Measurement of Variables

The measure of currently divorced for both 1990 and 2000 is the total number of persons (male and female) currently divorced per 1,000 population aged 15+. This measure is derived from the question on marital status that is asked of everyone on the census "short form." The census data reflect only those who were divorced at the time of the census. The income measure for both 1990 and 2000 is operationally defined as the median family income (using decennial census data) in each of the identified counties.

Shared religious affiliation in both 1990 and 2000 is derived from a statistical index that reflects the degree of concentration of formal religious groups within each of the selected counties. Following the approach of Ellison et al. (1997), we utilized data compiled by the Glenmary Research Center in 1990 and 2000 (Bradley et al., 1992; Jones et al., 2002) to create an index of shared religious affiliation (ISRA). The 1990 database provides an estimate of the number of church members and adherents at the county level for 133 denominational groupings in the United States, while the 2000 database includes 149 religious bodies. Although, as Ellison et al. (1997) have noted, these data may be limited in some respects, e.g., smaller religious groups may be underrepresented due to data gathering methodology, the Glenmary data nevertheless represent the most complete set of information available concerning church membership and affiliation in the United States.

The index of shared religious affiliation (ISRA) is operationally defined using an adaptation of the "Herfindahl Index." Initially used to determine monopolistic shares in legal proceedings involving antitrust cases, it was designed to measure the extent of corporate concentration within a given market area (Herfindahl, 1950). Originally, the index was calculated by summing the squares of the individual shares of competing firms within a given market area. In the current

research, the Herfindahl Index is adapted to measure the extent of persons within professed religious groupings in each of the 621 counties.

The general formula for the shared religious affiliation index (within the Herfindahl context) is: $ISRA_c = \sum N^2_{dc}$. N represents the number of adherents in each denomination within a county divided by the total number of church adherents in that county; d represents the index of the summation over all religious denominations in county c. ISRA represents the probability of any two persons, selected at random, within a county being adherents of the same organized religious group (Iannaccone, 1991). For example, a county has 20 discrete religious denominational affiliations with the following distribution: one has 40 percent of all adherents, one has 20 percent, two have 10 percent, and ten have 2 percent each. The index score is $H = .4^2 + .2^2 + 2(.1^2) + 6(.02^2) = .23$. In this case, the odds of selecting two persons at random with the same denominational orientation are 23 percent. Another county has five discrete religious denominations: one has 60 percent of all adherents, while the other four have ten percent each of the adherents. This county's index score is $ISRA = .6^2 + 4(.1^2) = .40$. Therefore, the odds of any two people selected at random having the same denominational affiliation are 40 percent.

The shared religious affiliation index is sensitive to the relative degree of concentration of adherents in a fewer or greater number of religious denominations. When more adherents are in a fewer number of denominations, the index score is higher and conversely. The theoretical range of shared religious affiliation is from 0.00 (no adherents with any affiliation) to 1.00 (all adherents within a county display a single affiliation). For purposes of this analysis, we have multiplied the individual index scores by 1,000 yielding a range of shared religious affiliation scores between 0 and 1,000.

Our measure of region of the country utilizes five identified regions. Five regions were utilized in order to optimize the number of counties in each area. Chart 1 shows the states and number of counties per state by region. Each region was coded as 1 = Yes or 0 = No.

Regions, states and number of counties within states

Northeast	South	Midwest	Plains	West
Connecticut(2)	Alabama(13)	Illinois(20)	Kansas(21)	Alaska(5)
Delaware(1)	Arkansas(15)	Indiana(18)	Nebraska(19)	Arizona(3)
Maryland(5)	Florida(13)	Iowa(20)	North Dakota(11)	California(12)
Maine(2)	Georgia(32)	Michigan(17)	Oklahoma(15)	Colorado(13)
Massachusetts(3)	Kentucky(24)	Minnesota(17)	South Dakota(13)	Hawaii(1)
New Hampshire(2)	Louisiana(13)	Missouri(23)	Texas(51)	Idaho(9)
New Jersey(4)	Mississippi(16)	Ohio(18)		Montana(12)
New York(12)	North Carolina(20)	Wisconsin(14)		Oregon(7)
Pennsylvania(14)	South Carolina(9)			Nevada(3)
Rhode Island(1)	Tennessee(19)			New Mexico(8)
West Virginia(11)	Virginia(19)			Utah(6)
Vermont(3)				Washington(7)
				Wyoming(5)
12 states (60)	11 states (193)	8 states (147)	6 states (130)	13 states (91)
24% (9.7%)	22% (31.08%)	16% (23.67%)	12% (20.93%)	26% (14.65%)

RESULTS

Descriptive Results

Table 1 shows the intercorrelations between the variables for both 1990 and 2000. These results show that the variables are a relatively independent set for both time frames. None of the correlations in 1990 is greater than r = .52 (between percent employed in manufacturing occupations and residence in the Plains region); in 2000 the highest correlation is r =.50 (between percent urban and county median income). As a result, there is no concern about multicollinearity in the subsequent regression analyses.

An examination of the key variables of interest and their association with the divorce rates for each of the two years in question leads to these conclusions. First, median income was positively and significantly associated with divorce rate in 1990, but was negatively and non-significantly associated with divorce rate in 2000. Second, shared religious affiliation was negatively and significantly associated with divorce rates in both 1990 and 2000. Third, in 1990 residence in the Plains region was negatively associated with divorce rate, while residence in the West region was positively associated with divorce rate. This same pattern was true for 2000 with the addition that residence in the South region was positively and significantly associated with divorce rate.

Table 2 shows the paired t- test comparisons between variable pairs, excluding region, in 1990 and 2000. This analysis shows that the rate of divorce did not substantially change in the decade between 1990 and 2000. There was only a .75 increase in the rate of divorce per thousand population in these 621 counties in 2000 compared to 1990. All the remaining variables showed a significant change in that time frame.

Comparing the 1990 means with the 2000 means showed significant increases in the percent population change and the percent urban population. The median income and the index of shared religious affiliation both showed an increase in the ten-year period. (Median income significantly increased even after recalculating the 1990 median income into 2000 dollars, using a conversion factor of 1.3 derived from the Consumer Price Index: 1990 = $37,014 (in 2000 dollars) compared to $41,677 (in 2000 dollars),
t = -33.96, p < .05 (1/620df)).

In contrast, percent female, percent unemployed, and percent employed in manufacturing occupations showed a significant decrease in percentages over time. All the control variables were significantly associated with divorce rate in 1990. Percent female was the only variable to show a negative correlation with divorce rate. In 2000, all the control variables showed a positive association with divorce rate, though the correlation between percent female and the divorced rate in 2000 was non-significant.

Divorce Rates Regressed on Control Variables for Both 1990 and 2000

Table 3 shows the multiple regression analysis results for both 1990 and 2000, when divorce rate was regressed on the five covariates. The direct effect of each covariate on divorced rate is shown with the other four covariates controlled. The results reflect in both direction and significance the earlier identified zero-order results for the two timeframes. In 1990, all five variables were significantly related to divorced rate with percent female having the only negative direction. In 2000, only percent female showed a non-significant relationship with divorced rate. This information is referred to as

Table 1. Intercorrelations between Variables in 1990 (N=621) and in 2000 (a=621) [a]

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
Divorce Rate (1)	-	.41*	.34*	-.17*	.13*	.11*	.21*	-.14*	-.06	.06	-.04	-.15*	.26*
% Population Change (2)	.21*	-	.26*	-.25*	-.06	.01	.48*	.00	.01	.12*	-.12*	-.19*	.28*
% Urban (3)	.15*	.19*	-	.13*	.01	-.05	.47*	-.11*	.07*	-.11*	-.03	.02	.12*
% Female (4)	.02*	-.29*	.07*	-	.06	.29*	-.16*	-.9*	.04	.20*	.09*	-.14*	-.27*
% Unemployed (5)	.16*	-.05	.01	.04	-	. 01	-.31*	.06	.00	.08*	-.01	-.10*	.05
% Employed Manufacturing (6)	.15*	-.02	-.05	.27*	-.05	-	-.01	-.01	.02	.43*	.18*	-.52*	-.17*
Median Family Income (7)	-.03	.34*	.50*	-.04	-.45*	.01	-	-.07*	.23*	-.23*	.08*	-.13*	.22*
Shared Religious Affiliation (8)	-.14*	.03	-.13*	-.03	.14*	-.05	-.16*	-	.04	.14*	-.21*	-.05	.13*
Northeast Region (9)	-.03	-.13*	.11*	.09*	.02	-.01	.16*	.00	-	-	-	-	-
South Region (10)	.18*	.17*	-.11*	.13*	.15*	.34*	-.22*	.23*	-	-	-	-	-
Midwest Region (11)	-.04	-,08*	-.02	.08*	-.10*	.29*	.16*	-.26*	-	-	-	-	-
Plains Region (12)	-.18*	-.16*	-.04	-.18*	-.19*	-.48*	.11*	-.07*	-	-	-	-	-
West Region (13)	07*	.23*	.15*	-.15*	. 19*	-.23*	.15*	.13*	-	-	-	-	-

[a] The correlations, means and standard deviations in the upper right quadrant refer to 1990 data; the information in the lower left quadrant refers to
2000 data.
* $p<$ (at least) 0.5 (one tailed)

Table 2. Paired t-test results: variables in 1990 compared to those in 2000 (N=621)

	1990		2000		
Variable	**M**	**SD**	**M**	**SD**	***t* (1/620df)**
Divorce Rate	75.45	18.59	76.20	16.90	-1.36
% Population Change	3.57	15.15	10.98	16.40	-15.10*
% Urban	34.83	29.28	38.38	29.60	-7.60*
% Female	50.90	1.95	50.36	2.19	8.37*
% Unemployment	6.91	4.92	5.81	2.69	6.59*
% Employed Manufacturing	18.57	10.81	15.82	9.01	15.72*
Median Family Income	28,094	7,014	41,700	9,649	-85.41*
Shared Religious Affiliation	297.26	146.20	325.79	163.25	-8.06*

*p< (at least) .05

"Block 1," since "Block 2" controls these as covariates, when the additional three variables are added.

In 1990, these five variables explained 28.9% of the variance in divorce rates, while in 2000 the same five variables explained only 11.4% of the variance in divorced rates. The amount of variance in divorced rates explained by these five variables in 2000 is less than half that explained in 1990.

Table 3. Divorce rate regressed on the five covariates for 1990-2000
Block 1

	1990		2000	
Independent Variable	b	β	B	ß
% Population Change	.36*	.29	.22*	.21
% Urban	.19*	.30	.06*	.11
% Female	-1.86*	-.20	.18	.02
% Unemployed	.58*	.15	1.11*	.17
% Employed Manufacturing	.29*	.17	.31*	.16
R^2 (5/615 df)	.289*		.114*	

* p < (at least) .05

Divorce Rates Regressed on Median Family Income, Shared Religious Affiliation and Region with Controls for Both 1990 and 2000

Tables 4 and 5 show the regression results on divorce rate in 1990 (Table 4) and 2000 (Table 5) of the impact of median family income, shared religious affiliation and region (viewed one region at a time) with the addition of the five covariates. Each table has five models. For 1990, these are labeled Model A90 through Model E90; for 2000, these are labeled Model A00 through E00. Each model includes eight variables, i.e., the five covariates plus median family income, shared religious affiliation, and one of the regions. Models A90 and A00 include the Northeast region; Models B90 and B00

include the South region; Models C90 and C00 include the Midwest region; Models D90 and D00 include the Plains region; and Models E90 and E00 include the West region. Rather than examining each separate model in depth, we will examine the general results for each year.

First, it is clear that in 1990 the five covariates maintained both the directionality of effect and level of statistical significance, shown in Block 1, after median family income, shared religious affiliation and region are added to the equation.

Second, the effect of median family income is relatively weak and inversely associated with the divorce rate. The direction of effect is in fact the opposite of that in the zero-order correlation. Median income is significantly and inversely related to divorce rate only when residence in the Plains and West regions is part of the equation.

Third, shared religious affiliation is significantly and inversely associated with divorce rate in each of the five analyses. Generally, the greater the index of religious affiliation, the lower the rate of divorce, irrespective of region.

Fourth, region is important in explaining the variance in the 1990 rate of divorce for the Northeast and the West. Residence in the Northeast is associated with lower divorce rates, while residence in the West is associated with higher divorce rates. The magnitude of the effect for the West is three times that for the Northeast (β = -.15 vs. β = .05).

Overall, the amount of variance explained by the eight variables in each of the five models in 1990 is statistically significant. The range in the five models is between 31.3 percent and 33.1 percent of the variance explained in divorce rate by the eight antecedent variables. Further, the change in variance explained when median family income, shared religious affiliation and region are included was significant also.

Taking the same approach to the interpretation of the regression analysis for the 2000 data leads to several conclusions. First, similar to 1990, the directionality of effect and level of statistical significance shown in Block 1 (Table 3) for the five covariates for the 2000 data are maintained after median income, shared religious affiliation, and region are added to the equation. Second, unlike the results for 1990, where percent female was inversely and significantly associated with divorce rate, the effect in 2000 of percent female was directly but not significantly associated with the divorce rate.

Third, median family income was inversely and significantly related to the divorce rate in 2000: The greater the county-level median income, the lower the rate of divorce in 2000, after controlling for the seven variables in the equation. Fourth, the negative directionality of the effect was the same for both the zero-order and the multiple regression analyses. However, the zero-order correlation between divorce rate and median income was not statistically significant, whereas with controls it was statistically significant.

Fifth, in 2000 shared religious affiliation was consistently and significantly inversely associated with the divorce rate across the models. Further, the level of the effect of shared religious affiliation was consistently robust and similar to the zero-order correlation between these two variables. Sixth, region was related to divorce rate only for the South: the divorce rate was significantly higher in the South in 2000.

Table 4. Divorce Rate Regressed on Median Family Income, Shared Religious Affiliation and Region with Controls (Block 2): 1990 (N=621)

Block 2: 1990

	Model A90 w/Northeast		Model B90 w/South		Model C90 w/Midwest		Model D90 w/Plains		Model E90 w/ West	
Independent Variable	b	ß	b	ß	b	ß	b	ß	b	ß
% Population Change	.39*	.32	.39*	.32	.39*	.32	.39*	.32	.37*	.30
% Urban	.20*	.32	.20*	.32	.20*	.32	.21*	.33	.20*	.31
% Female	-2.04*	-.21	-2.11*	-.22.	-2.08*	-.22	-2.13*	-.22	-1.80*	-.19
% Unemployed	.53*	.14	.51*	.14	.52*	.14	.48*	.13	.45*	.12
% Employed Manufacturing	.30*	.18	.29*	.17	.31*	.18	.26*	.15	.33*	.19
Median Family Income	-.00	-.08	-.00	-.09	-.00	-.09	-.00*	-.11	-.00*	-.11
Shared Religious Affiliation	-.02*	-.14	-.02*	-.15	-.02*	-.15	-.02*	-.14	-.02*	-.16
Northeast Region	-3.41*	-.05	-	-	-	-	-	-	-	-
South Region	-	-	.97	.02	-	-	-	-	-	-
Midwest Region	-	-	-	-	-1.36	-.04	-	-	-	-
Plains Region	-	-	-	-	-	-	-2.23	-.05	-	-
West Region	-	-	-	-	-	-	-	-	9.97*	.15
R^2 (8/612 df)	.315 *		.313*		.314*		.315 *		.331*	
R^2 (change) (3/612 df)	.026*		.025*		.025*		.026*		.043*	

*$p <$ (at least) .05

Table 5. Divorce Rate Regressed on Median Family Income, Shared Religious Affiliation and Region with Controls (Block 2): 2000 (N=621)
Block 2: 2000

	Model A00 w/ Northeast		Model B00 w/ South		Model C00 w/ Midwest		Model D00 w/ Plains		Model E00 w/ West	
Independent Variable	b	ß	B	ß	b	ß	b	ß	b	ß
% Population Change	.27*	.26	.23*	.22	.25*	.25	.25*	.24	.26*	.25
% Urban	.09*	.16	.09*	.16	.09*	.15	.10*	.17	.09*	.16
% Female	.18	.02	.08	.01	.17	.02	.12	.02	.21	.03
% Unemployed	.79*	.13	.78*	.12	.82*	.13	.61*	.10	.69*	.11
% Employed Manufacturing	.30*	.16	.23*	.12	.34*	.18	.22*	.12	.32*	.17
Median Family Income	-.00*	-.17	-.00*	-.13	-.00*	-.14	-.00*	-.19	-.00*	-.18
Shared Religious Affiliation	-.02*	-.15	-.02*	-.18	.02*	-.17	-.02*	-.16	-.02*	-.16
Northeast Region	.35	.01	-	-	-	-	-	-	-	-
South Region	-	-	4.01*	.11	-	-	-	-	-	-
Midwest Region	-	-	-	-	-3.02	-.08	-	-	-	-
Plains Region	-	-	-	-	-	-	-3.30	-.09	-	-
West Region	-	-	-	-	-	-	-	-	3.51	.06
R^2 (8/612 df)	.148*		.157*		.153*		.153*		.151*	
R^2 (change) (3/612 df)	.034*		.043*		.039*		.039*		.037*	

*p< (at least) .05

Last, the amount of variance explained in the divorce rate in 2000 by the eight variables was statistically significant. The amount of explained variance in divorce rate ranged from 14.8 percent to 15.7 percent across the five models. Also, the additional variance explained by the addition of median family income, shared religious affiliation, and region was significant, ranging from 3.4 percent to 4.3 percent, for each model.

DISCUSSION

The intent of this research is to examine the association between macro-social ecological variables. There is no assumption that these results are valid at the individual level. They do not suggest, for example, that couples move to or away from counties with less shared religious affiliation, or move to or away from a particular state or region of the United States. These results, however, could encourage researchers to develop and examine issues that focus on social psychological issues, e.g., an examination of how the level of shared religious affiliation at the local level might influence marital harmony at the individual (or couple) level.

For the current study, using a twenty percent random sample of counties from each of the fifty states, we addressed several questions. Controlling for known covariates of divorce rates was the rate of divorce at the county level influenced by: A) median family income, B) the degree of shared religious affiliation, and C) region of the country within which states are categorized. These issues were examined for the years 1990 and 2000. Additionally, changes between the 1990 and 2000 results were examined.

The results of the regression analyses with the addition of the three primary variables of interest in this research showed a different pattern of effect in 2000 compared to 1990. Median family income in 1990 had less influence in explaining the divorce rate than in 2000. In 1990, median family income was important to divorce rate only when the Midwest and West were controlled, while in 2000 it was important across the board, irrespective of region.

Shared religious affiliation was consistently significant and inversely associated with divorce rate in both time periods. Further, the magnitude of the statistical effect was similar in the two time periods and across regions.

The influence of region certainly shows a difference in the two time periods. In 1990, the divorce rate was lower in the Northeast, while the divorce rate in the West was higher. In 2000, the divorce rate was higher only in the South.

Overall, the explained variance by the included variables in divorce rate was considerably less in 2000 than in 1990. Generally, the amount of variance explained in 2000 by each of the models was half of what it was in 1990. The explained variance of the three variables of median family income, shared religious affiliation, and region over and above that explained by the five covariates was reasonably similar between 1990 and 2000.

One important result from this study indicates that greater shared religious affiliation at the county level was associated with lower rates of persons currently divorced. This pattern holds both over time and when the effects of the covariates, plus median family income and region of residence, were held constant.

The findings support other recent studies (Mullins et al, 2004; Mullins et al, 2006; Mullins et al, 2009; Gruber, 2005) that have probed the statistically independent

influence of shared religious affiliation on the divorce rate and, with the addition of the temporal dimension, enhance our ability to generalize over time. The results add to a small but growing body of evidence that the "religious context" itself may have an independent effect on divorce (as first posited by Durkheim in his classic studies of religion and suicide [1965; 1966] and later suggested by Weber in related work [1958]). Why should it be an *independent* effect? Generally, we theorize that greater agreement on religious matters perpetuated through high levels of "religious similarity" fosters a common set of cultural themes (including beliefs, values, and expectations) relative to marriage and "staying together" that operate over and above intermediary variables such as socioeconomic status, region of residence, and other factors that have been investigated in previous research by the authors (Mullins et al, 2004; Mullins et al, 2006; Mullins et al, 2009).

Still to be addressed, however, is more precisely how the religious factor operates. The literature suggests several directions. For one, similarity of religion may generate heightened agreement on values and normative issues related to marriage, resulting in a lower rate of divorce. Numerous studies at the individual, social psychological level, for example, have documented the influence of homogamy in mate selection and marriage, indicating that religiously homogamous couples have more successful marriages than "mixed couples" and are less apt to divorce (Call and Heaton, 1997; Heaton and Pratt, 1990; Ortega et al., 1988). Likewise, the social structure or "context" in which people live often constrains individual choices and personal desires (Blau et al., 1984; Larson and Goltz, 1989). Thus, religion as a part of that context (especially where unanimity of agreement is greater) may serve as a constraining influence on such "errant behaviors" as divorce. On the other hand, social communication also may play a broader, more positive role than that posited by Blau et al. (1984) in influencing behaviors. Ellison et al. (1997), for example, noted that religious groups tend to act in concert relative to the "message" they send to their individual parishioners. A central tenant of that message traditionally has been the importance of a lasting marriage.

One advantage of the longitudinal approach is the potential to track changes in patterns and statistical relationships. While an inverse association characterizes shared religious affiliation and divorce rate at both time periods, the association appears to have grown stronger over time.

Do these data indicate that religion is becoming less diverse in American society and more "homogenized"? Probably not, given that the sheer numbers of religious groups and the variety of religious expression in American society may be at an all-time high (Smith et al., 2002). After all, the Glenmary data added thirteen denominations from 1990 to 2000. Recent religious affiliation membership data indicate that more people are gravitating toward conservative bodies as well as so-called "other" religions.

Unexpectedly, the well-documented influence of region does not hold for both time periods. In 1990, the divorce rate for counties in the West was greater, while the divorce rate for counties in the Northeast was lower. In 2000, neither of these regions showed any significant association with divorce rate; the divorce rate in the South, however, was greater.

Just as the other institutions and traditions across the U.S. are becoming homogenized (e.g., Ritzer, 2004), the same may be true of divorce (although a single decade is hardly enough to establish a definitive trend). The issue that in the long run

that will require additional research is whether region continues to be a viable variable in understanding divorce.

The findings concerning the association between median income and divorce rate are equally intriguing. Based on the work of Clydesdale (1997), we expected an inverse association between the two variables over both time periods. This was very much the case in 2000, but in 1990 this was true only when residence in the Plains and West regions was controlled.

While ten years is a short time span, our belief is that income is becoming a more sensitive indicator of divorce than formerly, as indicated by the strong association in the 2000 model. This is supportive of suggestions from research by Sayer and Bianchi (2000) that examined the role of wives' earnings and divorce, and a study by Martin and Parashar (2006) that focused on women's education level and divorce attitudes. It appears that after a period of increasing permissiveness, attitudes about divorce may have stabilized during recent decades (Thornton and Young-DeMarco, 2001). While divorce has become a socially accepted pattern throughout American society, the characteristics of the social environment come into play with regard to the act of divorce. This, plus the mass movement of females into the labor force has fostered less economic dependence on males and more freedom to choose one's own life course. Indeed, the majority of divorces in American society today are initiated by women (Hewitt et al., 2006). This greater independence reflected in greater income seems to provide at least a partial answer to the findings in this study. That is, in counties with higher income levels, the divorce rate is lower.

As with all models, additional time will be required to judge the stability and efficacy of the relationships that have been identified. Given the inconsistent findings that have characterized Durkheim's contention of a link between religious factors and suicide rates (see Ellison et al., 1997 for a discussion), definitive conclusions concerning the influence of shared religious affiliation on divorce necessarily lie with additional research.

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ACADEMIC ADVICE FOR STUDENTS ABOUT INTERNSHIP SELECTION

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There are a number of different factors that should be taken into account when attempting to select an internship because the potential value of such an educational experience is great. Perhaps one of the most important concerns is what am I going to get out of it? The answers to this question will vary but certainly an internship should help a student decide if indeed a future career is one that should be pursued upon graduation. Hence, a student should be placed at an internship site that relates to a career. For example, if a student is hoping to become a lawyer, serving with a law firm would help answer this question for the student. Hence, the first question that this internship advisor asks of a student is "What do you want to do in life?"

If a student does a little advance research about various internship positions, he or she will find that internships will differ in their potential benefits. For example, one student who serves an internship with a particular interest group may receive a type of financial remuneration from the interest group. A different type of interest group may not offer such remuneration to interns. Thus, if money is an important factor in a student's decision, the fact that one agency offers money and another one does not could make the difference between the two agencies in terms of student selection. A good example of an instance in which money may be important would be an internship in Washington, D.C. The cost of living in Washington is probably higher than it is in most college communities, and it is a help for students if they are able to receive some type of financial reward to offset their expenses in that area. In addition, if a student has to pay a college or university for enrolling in an internship course while serving in Washington, D.C., the total cost of the internship experience could be quite high. One student of this internship advisor backed out of an internship credit in Washington, D.C. because she indicated that she needed the money that she would have spent on tuition for personal expenses. Hence, she served her internship but did not receive academic credit for it because she did not pay the cost of enrolling in the internship program. Yet, one must keep in mind that the primary goal of an internship is an educational opportunity. Thus, even if no pay is offered, a student may still be willing to accept an internship. The following comments were made in papers submitted to this internship advisor in 2012:

"I learned numerous things that I could not have learned in class, and it helped me solidify my career choices". "There are many benefits to doing this internship". The people you meet, the things you learn and the places you may go all contribute to an outstanding experience that will greatly benefit your outlook on life and the job market as well as open opportunities" (Kelly, 2012).

Another example of how internship positions differ in benefits occurs when one agency allows students to take on a great deal of responsibility while another one does not. For example, if one state politician who accepts a student as an intern allows that student to represent him or her at various events, formulate and give speeches, and actively participate in the formation of various bills, the student would receive a number of important benefits from the internship. However, if another politician requires the intern simply to maintain office hours and act as a type of receptionist, this intern will receive considerably fewer benefits from the internship experience. Hence, it is beneficial for students to compare different types of similar internships and determine which one is best for them.

A student can compare similar types of internship positions in a number of ways. First, it would be a good idea to ask an internship director about which particular internship might be best for the student. An internship director can use various sources including comments and papers from former interns to assess which particular internships seem to be providing the best educational opportunities for students. For example, if a number of students have indicated in their papers or verbally that too much of their time was devoted to unimportant mundane tasks, the faculty internship director should take note of this situation and not recommend that students intern with that particular agency. On the other hand, if the faculty internship director is informed on a regular basis from student interns that they have been given important responsibilities and have found their internship experiences to be quite valuable, the faculty internship director should encourage students to intern with these agencies.

In attempting to decide which internship to pursue, it is often helpful to read the "job descriptions" that agencies provide. This internship director has a large file of these and he regularly allows students to peruse them with the hope that they will answer some of the questions that students might have about serving with a particular agency. He also allows students to read papers submitted by other students who have interned at a particular agency. For example, if a student indicates he or she would like to intern with a judge, the student is given the opportunity to read several different papers about internship agencies associated with a judge's office, and then decide with which judge they would like to serve an internship.

Of course, students who have served internships often speak to other students about the benefits or lack thereof they have received at a particular position. Their comments may be more valuable than what is sometimes found in their formal written papers submitted to the faculty internship director. In addition, when a student who is presently serving as an intern informs another student of the benefits being received, it is helpful for the interested student to request the opportunity to accompany the present intern at the internship site for one day and observe what is really occurring at the agency. Faculty internship directors should encourage this one-day observation possibility because it is a very good way for a prospective intern to decide if the internship is really one that he or she would like to pursue.

Another important method in helping a student decide which internship experience should be pursued is to gain a sense of how comfortable he or she would be at the agency. One source suggests that a student be sure that he or she will be able to get along with the right supervisor at the agency (Posey, et al., 1988). It is apparent that some agencies appear to be more comfortable with students than other agencies. Often this is due to the type of personnel who are employed full time with the internship agency. Hence, if possible, prospective interns should do their best to find out how other interns were treated at the agency. For example, they may inquire as to whether the former interns were basically ignored, shunted into a corner, given very little responsibility, and prevented from gaining valuable insights about the agency. In

addition, they may ask if these former interns were made to feel that they were making a contribution and treated in a cordial manner by the full-time employees. First impressions are important, so the initial interview at the agency can go a long way toward making an intern feel comfortable. This is why it is important for the agency supervisor to extend a special effort to create a favorable atmosphere for the intern. This can be done by introducing the prospective intern to regular employees and attempting to find out from the student what he or she expects to gain from serving as an intern.

Another factor that a student should consider when attempting to secure an internship is whether or not an agency has a flexible schedule for their interns. If it does this would allow students to take classes while they serve their internship. For example, this faculty internship advisor allows students to enroll in a number of lecture courses in addition to serving as an intern. This allows a student to graduate on time without any major interruption. Of course, the flexibility needed to allow a student to enroll in lecture courses and still serve as an intern necessitates the cooperation of the host agency. However, it has been this faculty advisor's experience that most agencies are willing to accommodate interested students in this manner. In addition, it should be pointed out that it is helpful at times for the internship faculty advisor to note in a letter of recommendation to the agency supervisor that it will be necessary for a student intern to have a flexible schedule.

It is valuable to note that a faculty member or department can help bring flexibility to an internship program in a variety of ways. One way would be to allow the student to enroll in a readings course while he or she is participating in the internship program. For example, suppose a student is serving as an intern with a congressman's office. It would be a benefit to the student if he or she could be allowed to gain additional academic credit by submitting five reviews of books dealing with the legislative process and gain additional academic credit for this activity in addition to the academic credit received for completing the internship.

Another important factor to be considered when selecting an internship is determining which agency site would be more willing to employ the student full-time after graduation. For example, if some agencies use the intern experience as a means of selecting their future employees, this factor might be important in choosing the type of agency to consider for an internship. This faculty internship advisor has had a number of his students receive full-time employment after serving their internships. One source noted that "the best recommendation for internship programs comes from students who landed jobs" (English, 1985). This is probably more important today considering the present state of the economy.

It is not surprising that sometimes a student enjoys an internship experience so much that he or she requests to be allowed to serve another semester as an intern with the same agency. Hence, if an agency is willing to offer the same student a number of opportunities to serve as an intern with their organization, it may very well be advantageous for the student to select this particular agency over another. An extended internship gives the student a more in-depth opportunity to observe a professional setting over a longer period of time.

In some cases, the decision is also made for the student as to where he or she will serve an internship. This could occur in a situation in which the faculty internship advisor requires that his or her students serve in a particular agency that is known to provide substantial advantages to interns. The decision can also be determined by the simple fact that only one type of agency is available for a student. In this case, if a student indeed really wants to serve an internship, it must be done at this particular agency site.

There is no one best type of an internship because so many factors need to be taken into consideration when selecting an agency site. However, this advisor's personal experience suggests that one of the better types of internships would be one with the following characteristics:

1. It provides a meaningful educational experience that gives the student important insights into a profession that can only be obtained in a practical environment.
2. The student enjoys engaging in the internship and is happy serving with a particular agency.
3. The student is rewarded for participating in this particular internship by getting paid for it and being hired on a full-time basis after serving as an intern.
4. The student serves the internship while living at home and therefore has less living expenses than one encounters by having to pay room and board on campus.
5. The student receives a good grade for the internship, which enhances his or her grade point average.

Faculty internship advisor believes that the aforementioned characteristics of favorable internships are not always going to be found in all internship positions. Perhaps the best that can be said about them realistically is that there will be some negative factors associated with an internship, just as students will later find when they are employed upon graduation. In other words, no internship is going to be perfect and students should be aware of this. Hence, they should be encouraged to make an objective analysis of the potential benefits that could be gained by selecting one internship over another and then do the best they can while serving at the agency. This decision can be helped in a number of ways. For example, students could ask former interns about the value of their internship experience. They should also read carefully the job description put out by the agency to determine if what they will be doing will benefit them professionally. In addition, they should take the opportunity to spend at least a day at the internship office, and attempt to obtain a feeling of comfort in the environment, and meet some of the individuals at the agency. Doing so also provides the chance for a student to ask a wide variety of questions about their possible future internship activity at a pertinent time. It may also help them decide if they will enjoy being at a particular internship site. One source notes that "people are most successful in positions that utilize their strengths and skills, and that they are happy in" (Derricote, 2002). Of course, the same may be said of a full-time employment situation after graduation.

Sometimes there are a number of limitations on students regarding the securing of an internship, and students should be informed about them. For example, some intern programs may require that a student have a particular grade point average. Perhaps there is logic in this requirement because having a certain grade point average does demonstrate that the student probably possesses a number of important characteristics that could affect the successful completion of an internship. For example, a low grade point average may indicate a student's lack of motivation and low level of responsibility. Conversely, a very good grade point average may suggest a high level of intelligence, motivation, and initiative on the part of the student. A student may also be limited in participating in an internship by his or her major or class standing. For example, a political science internship director may require that a student be a political science major and either a junior or senior. This limitation may result from a desire to advise political science students as well as a belief that a junior or senior has had the proper academic background to help him or her achieve the maximum benefit from the internship. For example,

this advisor believes it is helpful for a student to have had a number of courses in political science such as law and society or the judicial process before participating in an internship with a lawyer, district attorney, or judge. This way the student is able to compare what was learned in class about the legal process with how such a process is carried out in a practical work environment. Sometimes students also have time limitations that prevent them from serving as interns. For example, they may not have the time to serve an internship because they have to complete required courses for graduation. It may also be that when these required courses are offered by the college or university, they conflict with the time period that a student could serve as an intern. In addition, it may be that an internship agency requires a student to serve for a definite time period each week, such as completing twenty hours of internship activity. Such a requirement may preclude a student from serving an internship with the agency. In this situation, it would be better for a student to seek out an agency that requires less time, such as one that allows a student to serve perhaps twelve hours per week.

There are some other limitations that may affect where a student will serve an internship. For example, if the internship is costly in terms of transportation, room and board, as well as tuition, a student may choose not to serve it. This might be the case with a student who is considering an internship in the office of a Washington congressman but lives a thousand miles away. In addition, some agencies may limit the number of students they will accept as interns for a semester. For example, a judge's office may accept one or two interns while some agencies may accept a larger number. Therefore, when considering various internship opportunities, students should be knowledgeable of any possible limitations that may prevent them from serving an internship with a particular agency. They should instead consider some other agency that better suits their situation.

At times internship directors might advise students that it is possible for them to create their own internships. This may be the best way for some students especially if they are not able to find a suitable internship as a result of consulting individuals at their educational institution. Therefore it would help if students focused on agencies in which they were really interested such as the case of a pre-law student who might want to intern with a local law firm. In addition, it would be advisable for a student to request a meeting with a representative of a possible intern agency and be prepared to indicate how he or she can be an asset to the agency.

College and university academicians often provide internship advice to their students in different ways. Often, placement offices and career centers advise students about internship opportunities. In some cases, academic internship responsibility is shared by a number of professors in a particular department. Perhaps this has the advantage of sharing the workload in terms of giving internship advice to interested students. In other situations, which seem more prevalent, the responsibility is given to one individual within a department who has a one-course release load. This could be the more beneficial way for a department because the internship director is given the opportunity to gain specialized knowledge about internships, especially after serving for a number of years. Yet, it is important to remember that we can expect more students to ask academicians about internship opportunities. Therefore, academicians and administrators of institutions of higher learning must be prepared to give sound advice to their students about internships.

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BROOKS/COLE CENGAGE Learning

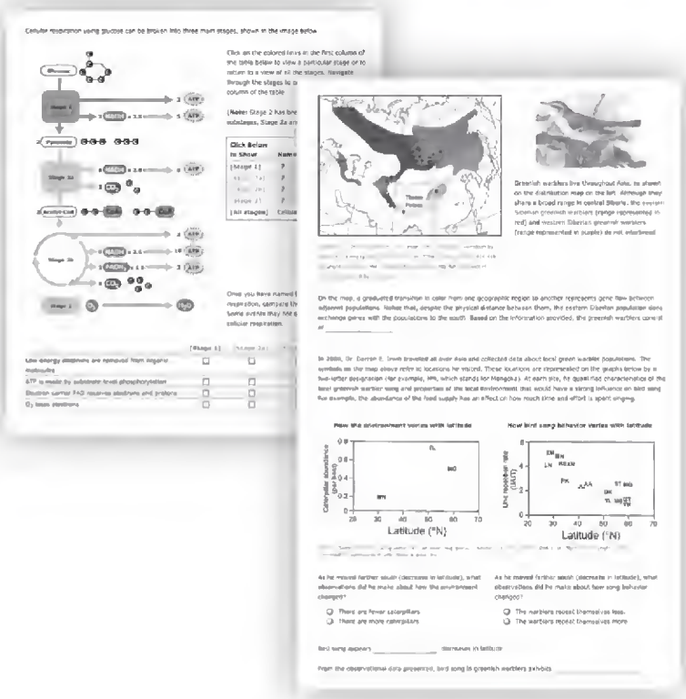
Aplia Biology

Improve comprehension and outcomes by increasing student effort and engagement!

Straightforward language, a simple and intuitive user interface, and online material that works hand-in-hand with specific biology texts from Cengage Learning, **Aplia** is the online program that reinforces course concepts and encourages students to think and learn.

Active Reinforcement

Aplia is an online, interactive learning solution that makes it easy to assign automatically graded problems that keep students on track throughout the term.



Interactive Figures

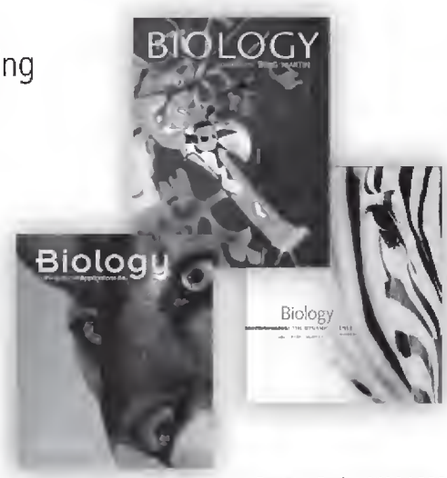
Vivid images with related questions help students come to class prepared and ready to participate.

Key Concepts

Interactive assignments and tools ensure that students succeed in grasping and applying fundamental course concepts.

Exercises Designed for Biology

Aplia's text-specific problems offer a variety of question types, including research-based exercises, and encourage students to think critically.



Aplia is available with:

- Non-majors Biology
- Majors Biology
- Environmental Science

Source Code: 11M-LS0090

More than a million students have succeeded with Aplia. Check out Aplia at www.aplia.com

Alabama Academy of Science Journal

Scope of the Journal:

The Alabama Academy of Science publishes significant, innovative research of interest to a wide audience of scientists in all areas. Papers should have a broad appeal, and particularly welcome will be studies that break new ground or advance our scientific understanding.

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- Manuscript layout should follow the specific guidelines of the journal.
- The authors are encouraged to contact the editor (E-mail: sah@jsu.edu) prior to paper submission to obtain the guidelines for the author.
- At least one author must be a member of the *Alabama Academy of Science* (except for Special Papers).
- The author(s) should provide the names and addresses of at least two potential reviewers.
- Assemble the manuscript in the following order: Title Page, Abstract Page, Text, Brief acknowledgments (if needed), Literature Cited, Figure Legends, Tables, Figures.

What and Where to Submit:

The original and two copies of the manuscript and a cover letter should be submitted to the following.
Dr. Safaa Al-Hamdani
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Review Procedure and Policy:

Manuscripts will be reviewed by experts in the research area. Manuscripts receiving favorable reviews will be tentatively accepted. Copies of the reviewers' comments (and reviewer-annotated files of the manuscript, if any) will be returned to the correspondent author for any necessary revisions. The final revision and electronic copy are then submitted to the *Alabama Academy of Science Journal* Editor. The author is required to pay $100 for partial coverage of printing costs of the article.

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